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USSR Report

MATERIALS SCIENCE AND METALLURGY



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MISCELLANEOUS

**Electrical Properties of RbAg₄I₅ Super Ion Crystals at
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ANALYSIS AND TESTING

UDC 669.295:538.214:537.311.31

CONVERSION OF METASTABLE PHASES UPON DEFORMATION OF HARDENED TITANIUM ALLOY VT23

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 21 Jan 54) pp 77-82

[Article by V.S. Ivanin, O.M. Ivasishin and N.V. Sviridenko, Sumy State Pedagogical Institute, Department of Physics]

[Abstract] A study is made of the interrelationship of the orientation of initial phases and phases formed in the process of deformation using alloy VT23 hardened from 800°C containing a mechanically unstable β -phase as the example. Deformation of this alloy by 5% causes martensitic $\beta \rightarrow \alpha''$ conversion. Increasing deformation from 5 to 10% causes further development of $\beta \rightarrow \alpha''$ conversion, but with differences in orientation relations and spreading of α'' phase reflexes. At 30% deformation the quantity of β -phase becomes quite small. At 50% deformation, the quantity of α'' -martensite of all orientations decreases. The experimental data thus indicate that deformation causes $\beta \rightarrow \alpha'' \rightarrow \alpha'$ (α) conversion. The concept of orthorhombic martensite as an intermediate phase between the β - and α -modifications of titanium can be used to describe these conversions. The texture formed is determined by the texture of the metastable β -phase in the initial hardened state and the plan for the application of external loads. Nonmartensitic mechanisms increase in the overall deformation as the degree of deformation increases, resulting in some deviation of the texture of the deformed alloy. References 13: 9 Russian, 4 Western.

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CSO: 1842/121

UDC 541.11:669.829'26

ACTIVITY OF STRONTIUM IN MOLTEN ALLOYS WITH TIN

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 9 Oct 84) pp 106-107

[Article by Ye.B. Klebanov, O.O. Tvaradze and A.G. Morachevskiy, Leningrad Polytechnical Institute, Department of Physical Chemistry]

[Abstract] The activity of strontium in molten alloys with tin is determined in this work for the first time. Solutions of strontium in molten tin were studied at 900 K by a method based on measurement of the depolarization upon deposition of strontium on cathodes that are alloys in the Sr-Sn system with various compositions. The studies were performed by measuring polarization curves under pulsed galvanostatic conditions, with polarization time and pause between rectangular pulses being 20 seconds each. Electrode potential was found to be independent of polarizing current density. Estimation of strontium activity was complicated by the fact that primarily potassium was liberated at the indifferent cathode from the $KCl-SrCl_2$ electrolyte. The values of strontium activity coefficients indicate a clear negative deviation from ideal behavior of the molten tin plus strontium alloys, suggesting strong interaction between particles in the liquid state. References 11: 7 Russian, 4 Western.

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UDC 669.2

THERMODYNAMICS OF INTERACTION OF METAL MELTS IN THE SYSTEM TERBIUM-ALUMINUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 31 Oct 84) pp 107-109

[Article by G.N. Zviadadze, S.V. Yemekeyev and A.A. Petrov, Metallurgy Institute imeni A.A. Baykov]

[Abstract] The purpose of this work was to measure the saturated aluminum vapor pressure over aluminum melts with terbium and to calculate the thermodynamic characteristics of the dissolution processes. The pressure was measured by high temperature mass-spectrometry in combination with the Knudsen method with evaporation from tantalum effusion chambers at 1560-1960 K. Data on the aluminum vapor pressure were used to calculate its activity in the melts. The minimum Gibbs energy of formation of Tb-Al melts corresponds to 67 At.%Al, which is equivalent to $TbAl_2$. The Gibbs energy of its formation is 34 kJ/mol. References 5: 3 Russian, 2 Western.

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UDC 669.856.87

THERMODYNAMIC PROPERTIES OF DILUTE PRASEODYMIUM-BISMUTH SOLUTIONS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 27 Jun 84)
pp 109-110

[Article by V.I. Kober, V.A. Dubinin, S.P. Raspopin and S.A. Kanevskiy,
Ural Polytechnical Institute, Department of Rare Metals]

[Abstract] The EMF method was used to determine the solubility of praseodymium in liquid bismuth at 880-1060 K and the thermodynamic characteristics of dilute praseodymium-bismuth solutions were calculated. A concentration-type galvanic element was used to measure EMF, eliminating contact of the metallic praseodymium with the salt melt, and assuring occurrence of disproportionation with the forming of Pr^{3+} ions in the melt. An equation is derived for the variation of praseodymium activity in saturated praseodymium-bismuth solutions as a function of temperature. The change in excess partial thermodynamic quantities of praseodymium in the process of formation of homogeneous praseodymium-bismuth dilute solutions is calculated. Formation of praseodymium-bismuth dilute solutions is accompanied by the liberation of large quantities of heat, decreases in Gibbs energy, and entropy. References 6: 5 Russian, 1 Western.

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CSO: 1842/121

UDC 669.017;621.785;669.21/23

INFLUENCE OF CONDITIONS OF TREATMENT ON GRAIN SIZE AND HIGH TEMPERATURE CREEP CHARACTERISTICS OF THE ALLOY P1RdPdIrZ1 20-10-0.1-0.1

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 19 Jul 84)
pp 112-113

[Article by F.S. Novik, deceased, A.Ye. Rudenko and Ye.I. Rytvin,
Stekloplastik Scientific-Production Association]

[Abstract] New data are presented on the influence of the degree of deformation, temperature and duration of homogenization and recrystallization annealing on grain size, high-temperature strength, and ductility of the alloy P1RdPdIrZ1 20-10-0.1-0.1 at 1400°C with an initial stress level of 5 MPa. Experiments were performed on specimens made from plates 6 mm thick. Grain size was determined by averaging 300-350 measurements. High-temperature creep characteristics were estimated by testing of specimens with a gage section of 40 x 5 x 0.5 mm. Time to failure is expressed as a dependent variable in a mathematical model based on a symmetrical irregular second order plan. The model can be used to select optimal treatment conditions for the

alloy considering the specific capabilities of the available technological equipment. Independent variables in the model include degree of reduction in rolling, temperature and time of homogenization annealing, temperature and time of recrystallization annealing. A table lists the grain size, creep rate, time to failure, and relative elongation of the alloys as functions of these independent variables. References 3: all Russian.

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BEHAVIOR OF SMALL NICKEL PARTICLES NEAR THE CURIE POINT AS A FUNCTION OF DIMENSIONS

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 3 Jan 85; in final form 15 Apr 85) pp 3147-3149

[Article by A.Ye. Petrov, Physics Institute, Latvian SSR Academy of Sciences, Salaspils]

[Abstract] Results are presented from an experimental study of the critical behavior of magnetization M_c and initial susceptibility χ of a set of spherical Ni particles of about 600 Å diameter. Measurements were performed on powders of nickel particles mixed with particles of Al_2O_3 . The concentration of nickel was 2% by volume. All experimental data were obtained by direct magnetic measurements. The Curie points and critical indices are presented in tabular form. References 6: 5 Russian, 1 Western (in Russian translation).

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MICROWAVE DIELECTRIC DISPERSION IN LEAD MAGNONIOBATE

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 15 Apr 85) pp 3161-3163

[Article by Yu.M. Poplavko, V.P. Bovtun, N.N. Kraynik and G.A. Smolenskiy, Physical-Technical Institute imeni A.F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] The microwave dispersion ϵ in lead magnoniobate is studied in detail. Measurements of the temperature variation of ϵ were performed on four waveguide installations in overlapping frequency bands from 7.7 to 74 GHz. Single crystals measuring 2.0 x 1.0 x 0.3 cm or smaller were oriented so that the [100] axis coincided with the direction of the electric field of the

rectangular waveguide. The error in measurement of ϵ' was not over 3%. Studies of the temperature variation of ϵ showed that in the microwave area, as at lower frequencies, there is a decrease in the maximum of $\epsilon'(T)$, which is displaced into the area of higher temperatures. At 74 GHz, the temperature of the maximum of $\epsilon'(T)$ is about 150 K higher than at 1 KHz. A maximum is also observed at microwave frequencies on the frequency curves $\epsilon''(\nu)$. As temperature increases, the maximum of $\epsilon''(\nu)$ shifts into the area of higher frequencies at a rate of about 0.07 GHz/K. There is a temperature maximum of absorption at around 650 K, the position of which is independent of frequency. References 6: 5 Russian, 1 Western.

6508/13046
CSO: 1842/113

UDC 534.8:536.424:669.245.295

ACOUSTICAL RADIATION UPON MARTENSITE CONVERSION IN TiNi-BASED ALLOYS

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 22 Apr 85) pp 3174-3176

[Article by V.A. Plotnikov, L.A. Monasevich and Yu.I. Paskal, Siberian Physicotechnical Institute imeni V.D. Kuznetsov, Tomsk State University]

[Abstract] Results are presented from studies of the acoustical emission accompanying martensite conversion in binary TiNi-based alloys containing 49.8, 50.3, 50.6, and 51.0 at.% Ni. The intensity, summary emission, and mean square voltage at the input of the measurement system were measured. During repeated martensite transformation cycles in the first three alloys, the acoustical emission decreased with increasing number of cycles, the decrease satisfactorily described by an exponential curve. As the concentration of nickel in the alloy increased, acoustical emission decreased in parallel with the decrease in phase hardening characteristics. In the fourth alloy, however, acoustical emission was greater upon reverse martensite transformation and the acoustical emission characteristics decreased little during the first few cycles, then remained constant. Acoustical emission in the first three alloys reflects the dissipation of energy in the process of formation of residual defects. The fourth alloy is closer to previously studied materials with thermoelastic martensite transformation in its acoustical emission characteristics. References 8: 5 Russian, 3 Western.

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CSO: 1842/113

UDC 669.85/.86.018:538:652

CRYSTALLINE STRUCTURE AND MAGNETOSTRICTION OF $Y_2Co_7H_{6.7}$ HYDRIDE

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60 No 5, Nov 85
(manuscript received 4 Mar 85) pp 864-867

[Article by A.V. Andreyev, M.I. Bartashevich, A.V. Deryagin, N.V. Kudrevatykh and Ye.N. Tarasov, Ural State University imeni A.M. Gorkiy]

[Abstract] A metamagnetic hydride $Y_2Co_7H_{6.7}$ was obtained with the highest known Neel temperature (470 K), the temperature at which metamagnetic phase transition occurs by the formation and growth of a ferromagnetic phase in an antiferromagnetic matrix, accompanied by magnetic hysteresis, when a magnetic field is applied along the axis of easy magnetization. The crystalline structure, magnetization, and magnetostriiction of single crystals of the hydride are studied. It is found that orthorhombic distortions are present in the compound. The anomalous variation of magnetostriiction as a function of temperature observed upon metamagnetic phase transition in the hydride, a sharp reduction of magnetostriiction with decreasing temperature, is related to ordering of hydrogen at the crystalline lattice interstices, leading to a significant reduction in the elastic constants of the crystal, and does not influence the induced magnetic moment of the substance. References 10: 7 Russian, 3 Western (2 in Russian translation).

6508/13046
CSO: 1842/115

UDC 669.15'782'781:539.213:669-153.63:538.6

INFLUENCE OF ANNEALING IN ALTERNATING AND PERMANENT MAGNETIC FIELDS ON MAGNETIC PROPERTIES OF AMORPHOUS ALLOY $Fe_{81}Si_7B_{12}$

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60 No 5, Nov 85
(manuscript received 28 Jan 85) pp 868-873

[Article by V.V. Shulika, A.P. Potapov, I.Ye. Startseva and A.A. Glazer, Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] A study is made of the possibility of using thermomagnetic treatment in permanent and alternating fields to destabilize the domain structure of amorphous alloys. The influence of thermomagnetic treatment on the magnetic properties of $Fe_{81}Si_7B_{12}$ was studied using strips of the alloy 20-40 μm thick and 2-4 mm wide obtained by hardening from a melt on a rotating disc to produce toroidal specimens on rolls 27 mm in diameter. Magnetic properties were measured after annealing at 350°C for 3 hours and after thermomagnetic treatment. Thermomagnetic treatment in an alternating field decreases both hysteresis and vortex-current loss components. It is suggested that after thermomagnetic treatment the domain structure becomes more ordered, while the domain boundaries shift more smoothly. At

frequencies over 40 KHz, however, vortex-current losses in anomalous materials are equal to the classical losses, and magnetic field annealing does not change them. In the alloy studied, even at 80 KHz the vortex-current losses are three times the classical losses, indicating an anomalous component which decreases under the influence of thermomagnetic treatment. References 8: 6 Russian, 2 Western (1 in Russian translation).

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CSO: 1842/115

UDC 669.15'781'782:669-156:538.22

MAGNETIC PROPERTIES OF RAPIDLY HARDENED IRON-SILICON-BORON ALLOYS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 12 Mar 85) pp 874-878

[Article by Yu.V. Yefimov, A. Andreyev, R.S. Torchinova, G. Festerling, O.N. Karyasova and V.N. Dmitriyev, Metallurgy Institute imeni A.A. Baykov, USSR Academy of Sciences; Technical University of Dresden, East Germany]

[Abstract] The purpose of this work was to study the temperature of magnetic phase transitions in amorphous, amorphous-crystalline, and microcrystalline rapidly hardened and tempered alloys in the trinary system iron-silicon-boron containing up to 50 at.% silicon and 30 at.% boron. Positional disordering causes the Curie point of the amorphous alloys studied to be lower than that of rapidly hardened microcrystalline alloys. The Curie point, crystallization temperature, and stability of the amorphous state in general increase with increasing total content of nonmetals and increasing relative fraction of silicon. When the Curie point is reached in a fully amorphous alloy, its magnetization drops to zero. Magnetization increases again sharply in the area of crystallization of the amorphous phase as the ferromagnetic crystalline phase appears. When an amorphous-crystalline alloy is heated to the area of the Curie point, the amorphous phase retains some weak residual magnetism. Subsequent heating of the alloy causes a gradual increase in magnetization. When amorphous iron-silicon-boron alloys crystallize, metastable supersaturated ferrite is formed, the Curie point of which is 670-720°C. References 6: 2 Russian, 4 Western (1 in Russian translation).

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UDC 669.15'24'295:541.65

INFRARED OPTICAL PROPERTIES AND STRUCTURE OF THE ALLOY $Ti_{50}Ni_{48}Fe_2$ UPON
B2 \rightarrow R TRANSITION

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 5 Feb 85) pp 879-888

[Article by I.I. Sasovskaya and V.G. Pushin, Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] The B2 \rightarrow R transition is accompanied by significant anomalies of electron physical properties, including the appearance of a negative temperature coefficient of electrical resistance. The authors of the present work use an optical method to study the electron structure of the alloy $Ti_{50}Ni_{48}Fe_2$ at 273-373 K. The variation of optical spectral characteristics, including index of refraction, index of absorption, optical conductivity, true and imaginary parts of complex dielectric permeability, and reflectivity are studied in the range of quantum energies of 0.07-1.24 eV. The crystal-line structure of the alloy was studied by transmission electron microscopy and microdiffraction of electrons, as well as x-ray diffraction. Optical data obtained for the B2 phase were compared with calculated data. A correlation is established between the IR absorption peak at 0.12 eV and the maxima in diffuse scattering and softening of transverse acoustical phonons in the region of structural conversion. It is suggested that the near IR area can be successfully used for indirect observation of softening of certain phonon modes upon structural transformations in metal alloys and compounds. No new absorption peak was observed upon B2 \rightarrow R martensitic conversion, as would be expected from previous theories. Studies at longer wavelengths are suggested. References 11: 5 Russian, 6 Western.

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ESTIMATE OF ACCUMULATED DAMAGE OF TURBINE VANE MATERIAL BY ACOUSTICAL EMISSION UNDER PROGRAMMED CYCLICAL LOADING

Sverdlovsk DEFEKTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 28 May 84) pp 29-34

[Article by M.D. Banov, Riga Institute of Civil Aviation Engineers]

[Abstract] Of known theories of the summation of damages, the hypothesis of linear summation of damages is the simplest, since it does not require the determination of additional parameters above the sums of relative durabilities. This article presents results of another approach to determining the value of summary damage by making the transition from the parameter of the number of cycles to the parameter of the total count of acoustical emissions.

A prerequisite for this replacement is the assumption that the acoustical emission parameters, including the summary count, directly reflect information on the nonlinear accumulation of fatigue damage in the material during programmed loading. This assumption is based on the physical nature of the development of acoustical emissions, one of the major sources of which is microplastic deformation. The parameters of acoustical emission, reflecting the actual picture of the process of accumulation of damage, do allow objective application of the hypothesis of summation of damages in each stage of multistep loading. References 11: 9 Russian, 2 Western.

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UDC 620.179.15

SENSITIVITY OF RADIATION METHODS OF DIAGNOSIS OF ELECTRICAL POTENTIALS IN DIELECTRIC MATERIALS

Sverdlovsk DEFEKTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 12 Mar 85) pp 35-39

[Article by Yu.I. Sapozhkov, L.F. Smekalin and N.I. Yagushkin, Scientific Research Institute of Electron Introspection, Tomsk]

[Abstract] Bombardment of dielectrics with electrons during testing of their parameters may result in the development of electric space fields, due to the accumulation of space charges, which change the spectral, angular, and quantitative characteristics of the reflected radiation, thus introducing errors to the measurements. Electron flux densities of over 10^{10} particles per second may actually cause internal electrical breakdown and mechanical damage to the dielectric. The characteristics of radiation methods of diagnosing electrical potentials within dielectrics are analyzed in this article on the example of the Albedo method using electrons with energies of less than 100 keV. The distribution of potential, which must be known for diagnostic purposes, can be obtained by solving equations presented in this article considering the boundary conditions. It is found that bombardment of a plexiglass film on an aluminum substrate with an electron flux density of 10^9 - 10^{10} particles/s/cm² for 100 seconds or less causes an increase in the backscattering coefficient of 2-8% for a film thickness of 22 μm . Increasing the atomic number of the substrate to 50 results in a greater change in the backscattering coefficient, amounting to 3-10%. In testing dielectric materials using β -isotopes or electrons of uniform energy, one must therefore consider the possible influence of the space charge on the measurement results. References 9: all Russian.

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NATURAL NONSHARPNESS AND FREQUENCY-CONTRAST CHARACTERISTICS OF GAS DISCHARGE CONVERTERS OPERATING IN AVALANCHE MODE

Sverdlovsk DEFECTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 7 May 84; in final form 27 Feb 85) pp 40-44

[Article by A.S. Kuleshov and V.K. Kuleshov, Scientific Research Institute of Electron Introscopy, Tomsk]

[Abstract] The natural nonsharpness of a gas discharge tube depends on the spatial distribution of mean ionization density and radius of the head of an avalanche. Calculated results indicate that the inherent nonsharpness of an optical image in a gas discharge converter filled with inert gases depends primarily on the nonsharpness of the latent image, determination of which can yield the frequency-contrast characteristics of the gas discharge converters. This article obtains equations for this purpose and estimates the resolution of converters filled with inert gases for effective radiation energies of 40 to 100 keV. Curves are presented which allow determination of the resolution of converters at minimum, near threshold contrast. Converters with a duralumin electrode can achieve a resolution of 0.17 lines per millimeter when filled with neon, 0.25 lines per millimeter when filled with argon, 0.6-0.8 lines per millimeter when filled with krypton, and 0.85-1.2 lines per millimeter when filled with xenon. References 16: 12 Russian, 4 Western (3 in Russian translation).

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DYNAMIC SYNTHESIS OF TOMOGRAMS OF A MOVING OBJECT

Sverdlovsk DEFECTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 27 Feb 85) pp 49-52

[Article by A.A. Popov, A.K. Stoyanov and V.V. Yanisov, Scientific Research Institute of Electron Introscopy, Tomsk]

[Abstract] Results are presented from the use of a device for dynamic synthesis of tomograms from x-ray motion pictures of the process of the movement of an object of constant geometric shape. The dynamic tomogram synthesis device is intended for layer-by-layer testing of objects moving continuously in a straight line parallel to the plane of transformation of the x-ray image to a visible image. The operating principle of the device is based on compensation for shifts in imaged points of the selected cross-section relative to the overall coordinate system. A precise image of the selected cross-section is formed on the summation photographic image carrier. The movement of the object creates the conditions necessary to

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NATURAL NONSHARPNESS AND FREQUENCY-CONTRAST CHARACTERISTICS OF GAS DISCHARGE CONVERTERS OPERATING IN AVALANCHE MODE

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[Article by A.S. Kuleshov and V.K. Kuleshov, Scientific Research Institute of Electron Introsopy, Tomsk]

[Abstract] The natural nonsharpness of a gas discharge tube depends on the spatial distribution of mean ionization density and radius of the head of an avalanche. Calculated results indicate that the inherent nonsharpness of an optical image in a gas discharge converter filled with inert gases depends primarily on the nonsharpness of the latent image, determination of which can yield the frequency-contrast characteristics of the gas discharge converters. This article obtains equations for this purpose and estimates the resolution of converters filled with inert gases for effective radiation energies of 40 to 100 keV. Curves are presented which allow determination of the resolution of converters at minimum, near threshold contrast. Converters with a duralumin electrode can achieve a resolution of 0.17 lines per millimeter when filled with neon, 0.25 lines per millimeter when filled with argon, 0.6-0.8 lines per millimeter when filled with krypton, and 0.85-1.2 lines per millimeter when filled with xenon. References 16: 12 Russian, 4 Western (3 in Russian translation).

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DYNAMIC SYNTHESIS OF TOMOGRAMS OF A MOVING OBJECT

Sverdlovsk DEFEKTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 27 Feb 85) pp 49-52

[Article by A.A. Popov, A.K. Stoyanov and V.V. Yanisov, Scientific Research Institute of Electron Introsopy, Tomsk]

[Abstract] Results are presented from the use of a device for dynamic synthesis of tomograms from x-ray motion pictures of the process of the movement of an object of constant geometric shape. The dynamic tomogram synthesis device is intended for layer-by-layer testing of objects moving continuously in a straight line parallel to the plane of transformation of the x-ray image to a visible image. The operating principle of the device is based on compensation for shifts in imaged points of the selected cross-section relative to the overall coordinate system. A precise image of the selected cross-section is formed on the summation photographic image carrier. The movement of the object creates the conditions necessary to

produce x-ray images of cross-sections within the object and can be used for tomographic testing of moving objects. Radiographic testing hardware, motion picture and image projection devices presently available can be used to synthesize tomograms of a moving object. References 3: all Russian.

6508/13046
CSO: 1842/125

UDC 669.295:548.53

DISORIENTATION OF GRAINS GROWN UPON RECRYSTALLIZATION OF TITANIUM SINGLE CRYSTALS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 19 Jan 85) pp 1033-1035

[Article by N.M. Knyazev and L.D. Kurmayeva, Physical Technical Institute, Ural Scientific Center, USSR Academy of Sciences, Ustinov; Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] Experimental studies were performed to establish the orientation relationships in high-purity titanium. Studies were performed on seven plates 1 mm thick cut from a single crystal along predefined planes. The distributions of disorientation parameters for a chaotic set of hexagonal crystallites were determined by methods not described here. It is found that most of the highly mobile boundaries observed in titanium have disorientation angles of 46-68° with disorientation axis near [1010]. Some of the highly mobile boundaries have irregular disorientation angles with axis near [0001]. The variation of mobility of boundaries as a function of axis and disorientation angle is generally quite nonmonotonic. References 8: 1 Russian, 7 Western.

6508/13046
CSO: 1842/115

UDC 620.192.47:621.315.592

DIFFUSION INSTABILITY OF COPPER SELENIDE SPECIMENS IN SUPERIONIC PHASE

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 27 Jun 85) p 125

[Article by N.Kh. Abrikosov and M.A. Korzhuyev, Moscow]

[Abstract] Observations were made of the blistering of metal-ceramic pressed Cu_{2-x}Se specimens annealed in the β-phase as a result of the formation of numerous pores up to 0.3 mm in diameter or larger in the volume of the specimen, and the growth on the specimen surfaces of bumps up to 0.5 mm high, some of which had the shape of sharply limited single crystals. The

effects are explained as follows: since the contents of adsorbed gases in the volume of cast and metal ceramic specimens without preliminary dispersion of the material is approximately the same, the blistering effect does not result from gases liberated during annealing. In Cu_{2-x}Se , whose plastic properties change upon heating more rapidly than internal stresses are relieved within an individual grain, conditions are formed for heterogeneous deformation of the material. The result is oppositely directed diffusion streams of material and vacancies, leading to the development of diffusion porosity. References 4: all Russian.

6508/13046
CSO: 1842/114

UDC 541.121:54-165

THERMODYNAMIC STABILITY OF $\text{Ga}_x\text{In}_{1-x}\text{P}_y\text{As}_{1-y}$ SOLID SOLUTIONS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 26 Mar 84) pp 2006-2010

[Article by V.V. Kuznetsov, P.P. Moskvin and V.S. Sorokin, Leningrad Electrical Engineering Institute]

[Abstract] An analysis is presented of the thermodynamic stability of $\text{Ga}_x\text{In}_{1-x}\text{P}_y\text{As}_{1-y}$ specimens based on a regular solution model. The calculations indicate that at temperatures below 950 K the area of absolute thermodynamic instability of single-phase alloys includes compositions in the isoperiodic InP series, which disagrees with previously published experimental data. The regular solution model also ignores nonconfiguration components of mixing entropy. The calculated positions of the boundaries of areas of instability depend on the parameters of interaction in the solid phase. The low speeds of solid phase diffusion in A_{III}B_V semiconductors inhibit spinodal decomposition at temperatures below the crystallization point. The critical temperatures of phase transition are sufficiently high to cause heterogeneous distribution of components as the alloy evolves toward equilibrium. The periodic modulation of the epitaxial layer composition is particularly evident. References 18: 7 Russian, 11 Western (1 in Russian translation).

6508/13046
CSO: 1842/120

UDC 546.814'24+546.289'24

INFLUENCE OF HEAT TREATMENT ON MECHANISM OF DISSOLUTION OF IMPURITIES IN
 $A^{IV}B^{VI}$ TYPE COMPOUNDS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 26 Mar 84) pp 2016-2018

[Article by Ye.I. Rogacheva, A.B. Ivanova, N.K. Zhigareva and A.G. Obedkov,
Kharkov Polytechnical Institute imeni V.I. Lenin]

[Abstract] A study is made of the influence of heat treatment on the variation of microhardness H and unit cell parameter a as functions of concentration in $A^{IV}B^{VI}$ plus impurity systems. Studies were performed on GeTe and SnTe doped with Cd, In, and Sb. The initial composition were $Ge_{0.975}Te$ and $Sn_{0.984}Te$, corresponding to the maxima on the fusion curves in those systems. Heat treatment included annealing at 820 K for 120 hours (type 1), 420 hours (type 2), and aging at room temperature for two years (type 3). All alloys subject to type 1 heat treatment showed a great increase in H and a upon introduction of up to 0.1-0.2 at.% impurity, after which the growth of a decreased, while H actually dropped right up to the boundary of maximum solubility (in the $Ge_{0.975}Te-Sb$ system it remains constant). After type 2 heat treatment in systems with Sb, microhardness monotonically decreases throughout the interval of solubility. The unit cell parameter increases more slowly than after type 1 heat treatment, reaching quite similar values at the boundary of the area of homogeneity. Aging results in no qualitative change in the concentration variation of properties in these systems, with the exception of $Ge_{0.975}Te-Sb$ system alloys in which the effect of type 2 and type 3 treatments is identical. These data indicate that the variation of properties as a function of composition is largely controlled by diffusion processes. References 1: Russian.

6508/13046
CSO: 1842/120

UDC 621.793.1:621.9.048.7

STRUCTURE OF THIN In_2O_3 FILMS DOPED WITH SnO_2

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 12 Oct 83) pp 2047-2051

[Article by B.S. Kolchev and V.M. Chutko]

[Abstract] Studies were made of the application of In_2O_3 films doped with SnO_2 by electron beam evaporation in a vacuum onto a substrate heated to 450 K with subsequent oxidation annealing in air. Immediately after application the films have a compact structure, high conductivity, good adhesion to the substrate, and are virtually opaque in the visible light range. During

oxidation annealing, transparency increases very little but conductivity decreases. Oxidation annealing seems to cause recrystallization of the layer with the formation of a polycrystalline structure with a lattice characteristic for In_2O_3 . The high porosity of the film as precipitated on a cold substrate allows access of oxygen during annealing to the deeper layers, yielding more complete oxidation than in a film precipitated onto a hot substrate. The oxidized film has a body-centered cubic lattice. The major factor determining the structure of the film is the substrate temperature. References 7: 5 Russian, 2 Western.

6508/13046
CSO: 1842/120

UDC 539.215.2:539.26

X-RAY EMISSION AND ESCA-SPECTRA OF THIN ZrO_2 -BASED FILMS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 9 Apr 84) pp 2059-2064

[Article by M.Ya. Khodos, V.M. Cherkashenko, N.V. Krivosheyev, V.R. Galakhov, S.N. Nemnonov, E.Z. Kurmayev and V.A. Gubanov, Chemistry Institute, Ural Scientific Center, USSR Academy of Sciences; Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences; All-Union Scientific Research Institute of Luminophors and Highly Pure Substances]

[Abstract] A study is performed by electronography, x-ray electron, and x-ray emission spectroscopy of the composition, structure, and nature of the chemical bond in thin films obtained by evaporation of ZrO_2 -based oxide mixtures containing oxides of group III-V metals in a vacuum. The thin films were obtained by electron beam evaporation in a vacuum of $(2-3) \cdot 10^{-3}$ Pa of targets of the following composition (in molecular fractions: ZrO_2 ; $0.75 ZrO_2 + 0.25 Al_2O_3$, $0.70 ZrO_2 + 0.30 Sc_2O_3$; $(1-x)ZrO_2 + xY_2O_3$ ($x = 0.01$; 0.03 ; 0.05 ; 0.1 and 0.2); $(1-x)ZrO_2 + xTiO_2$ ($x = 0.1$; 0.5); $0.90 ZrO_2 + 0.10 SiO_2$ and $0.60 ZrO_2 + 0.40 Nb_2O_5$). The substrate material was copper and molybdenum, the temperature $520-570$ K, and the precipitation rate $0.6-0.7$ nm/s. The specimens were 250 nm thick for ESCA spectroscopy and $0.8-1.6$ μm thick for x-ray emission spectroscopy. The composition, crystalline and electron structure of the thin films is found to be determined by the metal of the additive and its concentration. Changes in the electron structure of films in comparison with polycrystalline oxides indicate oxygen defects in the films. Titanium and niobium are in a higher degree of oxidation in the composition of thin films obtained by evaporation of oxide compounds containing TiO_2 or Nb_2O_5 in addition to zirconium dioxide. References 13: 6 Russian, 7 Western.

6508/13046
CSO: 1842/120

UDC 539.4:621.81

DETERMINING LOADS AND ESTIMATING STRENGTH OF ROTOR VANES DURING HIGH-SPEED FLOW AROUND THE ROTOR BY A STREAM OF LIQUID

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 85 (manuscript received 18 Mar 85) pp 14-17

[Article by S.I. Bogomolov, N.D. Gaydar, A.N. Lomakin and M. M. Smirnov, Kharkov Polytechnical Institute]

[Abstract] Results are presented from measurements of the pressure and deformation in the vanes of a rotary hydraulic machine type VVN2-50, the first time measurements have been performed on a spinning rotor during actual operating conditions. The method of installation and wiring of pressure sensors in the vanes is described. The experiments yielded oscillograms of deformation in the axial and radial directions, as well as at an angle of 45° to the axis, plus pressure oscillograms on the convex and concave sides of the vanes. It is found that the maximum pressure between vanes may be 50% higher than the maximum pressure in the output collector, indicating ineffective bypass valve operation. The vanes are found to experience complex loads, significantly depending on the angle of rotation of the rotor.
References 5: all Russian.

6508/13046
CSO: 1842/127

UDC 620.226.29

PARAMETRIC METHODS OF DESCRIBING AND EXTRAPOLATING LONG-TERM STRENGTH CHARACTERISTICS OF REFRACTORY MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 85 (manuscript received 14 Aug 84) pp 59-63

[Article by I.S. Tsvilyuk and D.S. Avramenko, Institute of Strength Problems, Ukrainian SSR Academy of Sciences]

[Abstract] A comparative analysis is presented of the effectiveness of parametric methods for description and extrapolation of the results of long-term testing of refractory materials. Methods compared included the Larsen-Miller, Sherby-Dorn, Menson-Sakkop, Conrad, and Korchinskiy-Klauss methods. The comparative analysis is based on the results of long-term testing of alloys of niobium and molybdenum. The best correlation is achieved by the Menson-Sakkop method, $\log T = A_0 + A_1 \log \sigma + A_2 \log^2 \sigma + A_3 T^{-1}$. The Sherby-Dorn method also achieves satisfactory results with the equation $\log T = A_0 + A_1 \log r + A_2 \log \sigma + A_3 T^{-1}$. Several methods must be used for reliable extrapolation of long-term strength characteristics to a base an order of magnitude greater than the base used in experiments.
References 10: 9 Russian, 1 Western.

6508/13046
CSO: 1842/127

ESTIMATE OF STRENGTH OF STRUCTURAL MATERIALS AT CRYOGENIC TEMPERATURES AND
EFFECTS OF ELECTRIC CURRENT PULSES

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 85 (manuscript received
10 Jan 85) pp 78-81

[Article by L.S. Novogradskiy, Kiev, Institute of Strength Problems,
Ukrainian SSR Academy of Sciences]

[Abstract] A study is made of one possible approach to determination of dangerous stresses when electric current pulses act on metals at low temperatures. The studies were performed on 12Kh18N10T and 03Kh13AG19 steels exposed to 2500 A pulses 10^{-2} s in length at 293, 77, and 4.2 K under conditions of uniaxial extension. Specimens 4 mm in diameter with a gage length of 20 mm were loaded to a specific level, active loading was stopped, and while the load was maintained constant electric current pulses were passed through. It was found that the metal begins to flow at stresses greater than the yield point at 293 K by a factor of 1.84-2.11, allowing low-temperature hardening to be used to increase the level of permissible stresses in the structural elements of electrical devices made of these steels and used under very cold conditions. References 7: 6 Russian, 1 Western.

6508/13046
CSO: 1842/127

COATINGS

WORK OF LATVIAN VACUUM METALLIZING ORGANIZATION OUTLINED

Moscow TRUD in Russian 16 Jan 86 p 3

[Article by special correspondent A. Pankov: "Unprecedented Quality Materials: What Vacuum Metallizing Promises the National Economy"]

[Text] At the "NTP [Scientific-Technical Progress]-85" exhibition held in 1985 in the Exhibition of USSR National Economic Achievements [VDNKh SSSR], I became interested in the booth of the Special Design Bureau for Vacuum Coatings attached to the Latvian SSR Gosplan. The specimens exhibited, for which the Special Design Bureau (SDB) received a certificate and several medals, and the fact that this design organization is subordinated to a republic Gosplan rather than to some ministerial department, intrigued me.

Blue rings of plasma glow brightly around a long, cylindrical cathode. Apparently, the temperature inside the apparatus is enormous. But one plainly sees through the peep hole that the plastic toy-car wheels attached to a slowly rotating drum do not melt.

Half an hour elapsed from the time the apparatus had been turned on to the completion of the vacuum operation. A worker opened the chamber, and barely warm finished parts emerged. How the dull plastic has changed! Coated with an extremely thin aluminum layer, it appears as if it has turned into a silvery metal.

The Straume Plant in Riga produces toys for children and various consumer products. But for some time their popularity has sharply decreased; above all, their external appearance is unsatisfactory. Therefore, a vacuum metallizing section was organized here. A decorative aluminum coating imparts a more colorful, modern appearance to the articles. The metallizing equipment was developed and manufactured by the SDB for vacuum coatings.

What is the idea behind this technology? Here it is briefly. We know from school that a vacuum is emptiness. If a substance is vaporized in a vacuum, there is nothing to prevent the particles from moving in a straight line. Having selected the requisite material, the method for vaporizing it, and the technology for the interaction of the "vapor" formed with the surface to be coated, we can deposit on various parts very thin films--decorative, protective, or those that impart new physical properties to an item. The SDB

specialists tested various versions of vacuum-coating units and technologies until they achieved an impressive success.

Thermal, electron-beam, electric-arc, and magnetron vaporization methods make it possible to use as coatings not only aluminum, but also other metals as well as alloys, particularly stainless steel, which is highly corrosion resistant.

The usual plastic parts for electrical engineering and plumbing items, radios, cars, and toys are given a "metallic appearance." The use of copper, magnesium, titanium, and brass for spraying opens new protective and decorative possibilities for vacuum technology. The use of titanium is probably the most promising. It forms titanium nitride or titanium oxide when it is vaporized, respectively, in an atmosphere of nitrogen or oxygen. Methods have been developed for using these compounds for imitation gold coating of table utensils, bracelets, dental plates, and other metal articles. These coatings have a longer life than real gold coatings. This saves the expensive metal. And you should see how ceramics can be changed. They can be given a mother-of-pearl color, perhaps, or one can make inscriptions and designs of a golden color.

Similar effects can be obtained with glass. Vacuum coating of eyeglass lenses darken them according to the dictates of fashion. Titanium nitride films are electrically conductive. This is utilized in the manufacture of automobile headlights and heat shields. Thanks to the SBD vacuum equipment, Latvian enterprises were the first in the country to use aluminum instead of silver in the manufacture of mirrors.

The SDB people do not limit themselves to work on consumer goods. They have developed equipment for metallizing condenser paper. Its use makes condensers much more reliable. There is also an installation for the production of ultra-thin copper foil, for coating of metal strip on both sides, for the metallizing of polymer films, nonwoven materials, and lavsan, and for coating of powdered materials.

All these technologies open up new production possibilities in many industries. Therefore, the SDB has broad ties with the most diverse scientific organizations and enterprises--from the Joint Institute for Nuclear Research in Dubna to toy factories. After learning about vacuum metallization, customers are glad to collaborate with the SDB, which is the only specialized organization in the country.

The collective, which was created only slightly more than 20 years ago only to work on the metallization of glass Christmas tree decorations, has succeeded in broadening its sphere of activity and is in the forefront in many directions of vacuum processing. What is the reason for this success?

"One could say, of course, that we have gathered a good collection of thinking, highly interested, skilled specialists," says the deputy director, Candidate of Technical Sciences E. Yadin, "but this, apparently, is not the main reason. Our SDB is an interindustry organization. Gosplan is, so to say,

our nominal master. No, of course we get our financing and personnel from Gosplan, but there is no petty tutelage, and report paperwork is reduced to a minimum. The most important thing is to fulfill agreements. And we never break them. Full cost accounting prompts us to work with precision and vigor and in the newest directions. Perhaps under the wings of a ministry we would be developing faster and be better equipped. But then we would work for a single industry, on its narrowly specialized problems. And I am convinced we would not achieve our present results."

Yes, the title of Special Design Bureau in essence no longer fits this organization. It is engaged not only in design but also in research and exploratory work. It produces pilot-scale prototypes with its small production base. It assists enterprises in the installation and setup of vacuum equipment and trains the operating personnel. That is, it has already become a scientific-production association, albeit a small one.

"People from all over the country ask us for help with the development (razrabotka) and manufacture of vacuum equipment for specific production units," says Z. Aumeyster, a division head of the republic Gosplan. "However, the SDB can satisfy only one-fifth of the requests. We have frequently raised the question of whether the SDB should be expanded. Indeed, the State Committee for Science and Technology is helpful in the development of scientific-research and design work; recently, it allocated us additional personnel. But the problem should be solved in a fundamental manner--the size of the SDB should be at least doubled. This has been proposed to the Gosplan, but no decision has been made. And I emphasize, the development of the SDB is necessary for the entire national economy. Vacuum metallizing is a technology of the future. In my opinion, this should be reflected in the Basic Directions for the development of the country. But today the series production of equipment created in Riga experiences a squeaky going; the Kazan Vakuummash Production Association serially manufactures two types of the Riga equipment, but these are from an obsolete design. This is how things stand thus far."

Upon my return from Riga, I asked the USSR State Committee for Science and Technology for explanations. I was told at the interindustry technologies and new structural materials department that the Riga SDB has been included in the pertinent all-union scientific and technical program, but only with respect to two types of equipment, which the Ministry of the Electrical Equipment Industry will begin to produce--one starting in 1986 and the other in 1990. How about the other types? When will it be a matter of their series production? Who, in a broad sense, will comprehensively resolve the problem of the development of vacuum metallizing in the entire country?

I was unable to get the answer at the State Committee for Science and Technology. I was told that the questions of the series manufacture of installations and construction of the second stage of the SDB are within the competence of USSR Gosplan. P. Usachev, chief specialist of the machine-building consolidated department, informed me of the measures undertaken to develop surface spraying in general.

"Specifically, what about vacuum technology," I asked. "This is too specific a question for us. Talk about it with the State Committee for Science and Technology."

Gosplan answered the question of the construction of the second stage of the SDB, but not to my satisfaction.

It is possible that on the national scale the savings of more than 49 million rubles achieved from introduction of SDB developments into the national economy during the 11th Five-Year Plan alone is "too specific a question." But, you see, these are merely the first steps of the new technology, which conserves resources, produces almost no waste, and is ecologically clean.

What further arguments are needed in favor of the accelerated development of this interindustry technology, which so far remains for many people merely something exotic.

12973/13046
CSO: 1842/129

UDC 621.79:669.293

INTERACTION OF Cr-Ti-Si COATINGS ON NIOBIUM ALLOY VN-3 WITH AIR

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 19 Nov 84) pp 94-97

[Article by E.M. Lazarev, A.T. Kozlov, L.A. Monakhova, V.F. Shestova and
I.V. Romanovich]

[Abstract] Results are presented from studies of Cr-Ti-Si coatings on niobium alloy VN-3, which contains 4.8% Mo, 1.48% Zr, and 0.02% C, upon oxidation in air at 1200-1600°C. Coatings were applied by thermal diffusion in two stages: vacuum chromotitanation in a mixture of chromium and titanium powders with an activator, and vacuum siliciding in silicon powder with an activator. The protective layer produced was 100-120 μm thick. This combined diffusion method produces a coating consisting of NbSi_2 enriched at the surface with chromium and titanium disilicides separated from the protected alloy by a narrow strip of the lower silicide of niobium Nb_5Si_3 . The coating protects niobium alloys from oxidation in air at 1200°C for 100 hours, 1400°C for 25 hours, and 1600°C for 17 hours. The coating operates by selective oxidation of chromium and titanium disilicides, and at 1600°C niobium disilicide as well, plus rapid diffusion of niobium and silicon through the Nb_5Si_3 and NbSi_2 and oxygen through amorphous SiO_2 .
References 10: 6 Russian, 4 Western.

6508/13046
CSO: 1842/114

COMPOSITE MATERIALS

UDC 661.66+537

CONTACT INTERACTION OF SILICON MELT WITH CARBON-GRAFITE FIBER MATERIALS

Moscow NEORGANICHESKIYE MATERIALY In Russian Vol 21, No 12, Dec 85
(manuscript received 26 Mar 84) pp 2032-2037

[Article by S.K. Brantov, Yu.N. Zakharov, V.A. Tatarchenko and B.M. Epelbaum,
Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] A study is presented of the interaction of a silicon melt at a temperature close to the melting point with various carbon fiber materials obtained from hydrate cellulose raw materials based on textile filaments or viscose cord. The resultant silicon on fabric materials had varying silicon content, depending on the type of fiber material but not on contact time. The filament diameter of all the materials studied was 10 μm . The silicon on fabric materials contained less than 1 mass.% free carbon. The carbon-silicon carbide matrix of the material is formed by simultaneous saturation and carbide formation. The textile-based material is saturated more rapidly than the viscose cord-based material. Modification of the initial carbon fiber material with up to 40% pyrocarbon improves saturation but hinders carbide formation due to the aggregation of fiber filaments. The kinetics of carbidization can be calculated by representing the carbon fiber materials as independent cylindrical filaments when less than 5% pyrocarbon is present. References 8: 6 Russian, 2 Western.

6508/13046
CSO: 1842/120

UDC 621.74.004.12:669.11

STRUCTURE AND MECHANICAL PROPERTIES OF ALLOYS IN SYSTEM Fe-C-Cr WITH ADDITION OF CERIUM AFTER DIRECTED CRYSTALLIZATION

Moscow LITEYNNOYE PROIZVODSTVO in Russian No 12, Dec 85 p 5

[Article by E. Fras, doctor of technical sciences, and E. Guzik, candidate of technical Sciences]

[Abstract] The structure and tensile strength of eutectic composite alloys in the system Fe-C-Cr with small quantities of cerium were studied as functions

of solidification rate. Metallographic studies of transverse and longitudinal cross-sections etched with aqua regia showed that at the solidification rates produced three major structures were obtained: A pure composite material obtained with a flat front of eutectic growth; an alloy structure appearing with a cellular growth front; and an alloy with hypereutectic boundary carbides $(\text{Cr}, \text{Fe})_7\text{C}_3$. Statistical calculations performed on a Hewlett Packard-30 computer indicate that a small quantity of cerium added to the eutectic alloy helps to reduce the intercarbide distance, which is equivalent to a decrease in the diameter of the carbide fibers. Analysis of the regression equations and curves of tensile strength as a function of solidification rate indicate that for each alloy type tensile strength is proportional to solidification rate. The addition of cerium increases tensile strength at a constant solidification rate. References 2: both Western.

6508/13046
CSO: 1842/128

CORROSION

UDC 621.311.25:621.039

CORROSION STATUS OF CONDENSATE LOOP IN ATOMIC ELECTRIC POWER PLANT WITH WATER-GRAPHITE CHANNEL REACTOR DURING STANDBY PERIODS

Moscow TEPOENERGETIKA in Russian No 6, Jun 85 pp 14-16

[Article by T.Kh. Margulova, doctor of technical sciences, V.A. Mamet, candidate of technical sciences, V.F. Tyapkov, candidate of technical sciences, V.A. Yurmanov, engineer, N.I. Bogdanov, candidate of chemical sciences, A.I. Gromova, candidate of technical sciences, V.N. Belous, engineer, and V.N. Baranov, engineer, Moscow Power Engineering Institute, All-Union Scientific Research Institute of Atomic Electric Power Plants, Chernobyl AES, Scientific Research and Design Institute of Power Technology]

[Abstract] Corrosion tests were performed in the Chernobyl AES with an RBMK-1000 MW water-graphite channel reactor, specifically in the condensate loop of its turbine plant with approximately 500 m^2 surface area of St 20 carbon steel and approximately 9100 m^2 surface area of 08Cr18Ni10Ti austenitic stainless steel. Samples of these steels were immersed in special containers along the bypass lines of five low-pressure preheaters. Tests were run for 1500 h, covering 700 h of operation and 800 h of standstill. Corrosion was measured by the gravimetric method at the five preheater temperatures (42.6, 67.4, 88.2, 108.5, 134.2°C). From these data the total specific loss of mass (g/m^2) were determined, as well as its fraction lost by passage into the water and its fraction lost by formation of the dense oxide film. The results indicate that, as of now, both steels are not adequately protected against corrosion during standstill. For the carbon steel, the corrosion rate during standstill decreases along the condensate loop from higher than during operation in the initial segment to the same level as during operation in the last segments. For the stainless steel, the corrosion rate during standstill increases along the condensate loop to a level 3-4 times higher than during operation in the last segments, but without significant passage of the iron oxides into the condensate. Excessive corrosion of piping, and especially piping joints made of carbon steel, can be prevented by deaeration and desalination of the water during lengthy standstill periods and/or modification of the coolant with special reagents during operation.

References 3: all Russian.

2415/13406
CSO: 1842/132

FERROUS METALS

UDC 537.226.4

OPTICAL AND ELECTROOPTICAL PROPERTIES OF FERROELECTRIC K_2ZnCl_4 CRYSTALS

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 5 Apr 85) pp 2992-2995

[Article by S.V. Melnikova, I.N. Stolovitskaya, T.N. Davidova and A.T. Anistratov, Physics Institute imeni L.V. Kirenskiy, Siberian Department, USSR Academy of Sciences, Krasnoyarsk]

[Abstract] Polarization-optical observations are made and the temperature variations of birefringence and of the coefficients $r_1 = (n_2 r_{23} - n_3 r_{33})$ of the electrooptical effect are measured in order to study phase transitions in K_2ZnCl_4 . Polarization-optical observations were performed on an MIM-8 microscope. Birefringence was measured for the major crystallographic directions using a compensator with magneto-optical modulator; electrooptical measurements were performed at an electric field frequency of 1 KHz by a dynamic method. The single crystals used in the study were grown by evaporation from aqueous solutions of KCl and $ZnCl_2$. The most significant changes in birefringence are observed at a low temperature transition at T_1 , which shows clear characteristics of a transition of the first kind, the birefringence shift reaching $0.6 \cdot 10^{-4}$, with temperature hysteresis of birefringence about 1 K. The studies indicate that the behavior of the optical and electrooptical properties of this ferroelectric upon successive phase transitions are similar to those of Rb_1ZnCl_4 and other known K_2SeO_4 -type ferroelectrics. References 10: 8 Russian, 2 Western.

6508/13046
CSO: 1842/113

UDC 669.15'24'26-194:669-156:539.56

INFLUENCE OF COOLING RATE IN AUSTENITE STATE ON NATURE OF FRACTURE OF HIGH-PURITY STEEL

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 27 Jun 84; in final form, 7 May 85) pp 907-913

[Article by A.B. Kutin, V.D. Sadovskiy, N.M. Gerbikh, L.V. Smirnov and
A.M. Polyakova, Metal Physics Institute, Ural Scientific Center, USSR Academy
of Sciences]

[Abstract] A study was made of the influence of 0.02% P and 0.03% Sb on type 37KhN3 high-purity steel containing 0.34% C, 1.4% Cr, 3.0% Ni, 0.0018% S, 0.001% P, and 0.0005% Sb, with or without 0.5% molybdenum. The purpose of the work was to determine the influence of cooling rate in the austenitic state of hardened and tempered high-purity steel and steels with various contents of impurities on impact toughness and the nature of fracture. It was found that changes in the cooling rate of high-purity steels in the austenitic state may lead to redistribution of sulfides as a function of cooling rate. The result of this redistribution of inclusions between grains and grain boundaries is weakening of between grain bonding and grain-boundary fractures. It is thus necessary in high-purity steels to adjust heat treatment modes, controlling not only the heating temperature and cooling rate in the area of transformation of the supercooled austenite, but also the cooling rate in the area of the stable austenite state. References 7: 2 Russian, 5 Western.

6508/13046
CSO: 1842/115

UDC 669.14.018.252.3:669.046.516:539.188

MODIFICATION OF SURFACE OF R6M5 STEEL UNDER THE INFLUENCE OF HIGH-CURRENT ION BEAMS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 11 Nov 84) pp 931-935

[Article by O.Kh. Asainov, A.N. Didenko, V.P. Krivobokov, A.D. Pogrebnyak and Sh.M. Ruzimov, Scientific Research Institute of Nuclear Physics, Tomsk]

[Abstract] The purpose of this work was to study certain specifics of the effects of high-current ion beams on the structural characteristics of R6M5 high-speed tool steel. Specimens of R6M5 steel, discs 20 mm in diameter and 4 mm thick with ground end surfaces, were bombarded with carbon ions with a mean energy of about 1 MeV. The pulse length at half height was 50 ns. Bombardment formed a modified surface layer 1.0-7.5 μm thick with austenite structure and microhardness $H_{20} = 3400-3600 \text{ MPa}$. X-ray structural analysis did not permit production of reliable data on the status of the structure at

sufficient depth, so the method of electron-positron annihilation was used. Curves of angular distribution of annihilation photons were constructed. These curves indicate that changes in lattice structure upon high-energy bombardment differ from changes occurring with continuous-method ion implantation. The concentration of structural defects is higher and phase transformations occur. The greatest changes in the structure are observed at distances from the surface corresponding to the maximum possible depth of penetration of the liquid phase. References 8: 7 Russian, 1 Western.

6508/13046
CSO: 1842/115

UDC 621.181.021.2.001.5:669.15'26'28'292-194

INFLUENCE OF AGING ON THERMAL STABILITY OF STEEL AFTER COLD PLASTIC DEFORMATION

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 85 (manuscript received 1 Mar 84) pp 75-77

[Article by M.B. Balakhovskaya, Ye.I. Kaminskaya, N.A. Khusainova and N.V. Bugay, Chelyabinsk]

[Abstract] A study is presented of the properties of cold deformed metal after long-term high temperature aging. Studies were performed on hot-rolled steam pipe metal, type 15 Kh1M1F steel, subjected to laboratory heat treatment consisting of austenitization with subsequent cooling at various rates and high tempering to achieve different structural states: high strength (bainite), minimum strength (ferrite-carbide) and intermediate strength (ferrite-bainite structure). Austenitization was performed at 1050°C for 25 minutes and tempering at 750°C for 10 hours. The pipe was stretched by 10-13% to imitate bending. The metal was studied in its initial state and after aging at 600°C for 2200 and 4000 hours and at 620°C for 4000 and 7000 hours. Aging equivalent to 100,000 hours use was found to decrease strength and increase ductility and toughness. The yield point decreased by 25-40%, relative elongation increasing by 50-100%. Increasing aging to $2 \cdot 10^5$ hours had little influence on mechanical properties. Tempering at 750°C over 5 hours after deformation reduced the influence of aging on mechanical properties, the change in mechanical properties over 10^5 - $2 \cdot 10^5$ hours being 2-18%. Strength and toughness of deformed and tempered steel with ferrite-carbide structure were lower in the initial state and after aging than for bainite structure. Ferrite-carbide structure metal also experienced greater segregation and coagulation of the carbide phase.

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CSO: 1842/127

UDC 621.74.002.6:669.14

PROPERTIES OF STEEL IN MASSIVE STERNPOST CASTINGS

Moscow LITEYNNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 19-20

[Article by A.T. Oshurkov, R.I. Mityukhina and V.M. Golod, candidates of technical sciences]

[Abstract] A study was made of the structure and properties of the metal in a large casting, the central portion of a ship's sternpost, with a mass of 42.2 tons, rejected after final heat treatment due to large numbers of irreparable defects including hot cracks. It was found that the deterioration in properties in the central zone of the main cross-section of the casting resulted from the presence of cavities and nonmetallic inclusions, sulfides, and oxisulfides, measuring 10-100 μm , facilitating failure of the metal when a certain level of stress was reached in the casting. Serious shrinkage defects were also seen, probably because of insufficient feed, poor design of the casting, and the presence of nonmetallic inclusions. An additional side feed system with two conical risers at an angle of 90° is suggested. This technology should allow production of quality castings and improve technical-economic results, decreasing the rough mass of the casting by 4 tons, reducing the consumption of liquid steel by 14 tons, and increasing the yield of usable castings by 14%. The suggested method has been successfully tested. References 1: Russian.

6508/13046
CSO: 1842/128

UDC 669.046:620.172.22

INCREASING WEAR RESISTANCE OF 110G13L STEEL BY MEANS OF COMPOSITE ALLOYING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received 22 May 85) pp 59-63

[Article by V.P. Rasshchupkin, V.L. Volodin, N.V. Dadochkin, S.A. Katyk, V.V. Yerastov and Yu.I. Kuz, Siberian Metallurgical Institute]

[Abstract] Composite alloying of 110G13L steel to 1.3% Cr + 1.20% Ni + 0.6% Mo + 0.03% Ti having already been found to improve its microstructure and thus increase its static strength as well as its fatigue limit, a study was made to determine the feasibility of also increasing its wear resistance. Cast specimens of plain and alloyed steel, 25 cm long bars 10 x 10 cm^2 in cross-section, were quenched from 1050°C in water. They were subsequently tested for wear by abrasion with 360 x 140 x 127 grinding wheels 64S25 and SM26K1A in a lathe (wheel speed 20 rps, feed rate 0.1616 mm/rev) for 600 s as well as with a powder blast (specimen rotating at speed of 1.5 rps and turned through a 120-125° angle after each revolution) for 1 h or equivalent of 795-825 m linear travel. Subsequent hardness measurements

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6508/13046
CSO: 1842/128

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Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received 22 May 85) pp 59-63

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6508/13046
CSO: 1842/128

INCREASING WEAR RESISTANCE OF 110G13L STEEL BY MEANS OF COMPOSITE ALLOYING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 22 May 85) pp 59-63

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with a PMT-3 tester revealed an increasing depth of cold working with more uniform microhardness distribution over that layer and thus higher wear resistance, surface microhardness not being the determining factor. Metallographic examination under an MIM-7 optical microscope, of the fine structure also under a UMB-100K electron microscope and under an REM scanning electron microscope, as well as microstructural examination in a DRON-2.0 x-ray diffractometer with a CuK α source by the Debye-Sherer method, indicate favorable results of composite alloying as manifested in breakup of the block structure and diminution of the austenite grains along with strain-induced twinning and dispersion of carbides. References 8: 6 Russian, 2 Western (both in Russian translation).

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CSO: 1842/133

UDC 669.140

EFFECT OF ARSENIC ON HIGH-TEMPERATURE OXIDATION OF LOW-ALLOY STEELS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 4 May 84) pp 76-78

[Article by L.N. Kudryavtseva, M.A. Shumilov, F.K. Tkachenko, Zhdanov Metallurgical Institute]

[Abstract] Since the Kerch iron ore used for steel making at the Azovstal combine contains arsenic, it has been found necessary to determine the effect of arsenic on the oxidation characteristics of low-alloy high-temperature steels produced there. A study of three such steels was made, namely, 16GS (0.17% C, 1.45% Mn, 0.133% As), 16G2SF (0.17% C, 1.42% Mn, 0.12% V, 0.132% As), and 18G2SF (0.21% C, 1.23% Mn, 0.13% V, 0.129% As), each of them with that arsenic content and without arsenic but with a somewhat higher carbon content and manganese content. Metal molten in a laboratory induction furnace was cast into 15 kg ingots and the latter were rolled into 20 mm thick strips, with the final rolling temperature 930-950°C for 16GS and 16G2SF steels and 830°C for 18G2SF steel. Those flat strips were then exposed to oxidation in air, inside a tubular furnace at constant temperatures of 500-600-700-800-900-1000°C for 1 h at each. The oxidation rate was measured by weighing on an analytical balance in 10 min intervals without removal of specimens from the furnace. The specific increment of mass Δq g/(m²·h) was found to be a parabolic function of time $\Delta q^n = kt$ at temperatures of 600-800°C and a logarithmic function of time $\Delta q = k_1 \log t + k_2$ above 800°C. A comparative evaluation of these data reveals that arsenic consistently lowers the oxidation rate, this inhibiting effect of arsenic depending on the grade of steel and being stronger in these low-alloy steels than in carbon steels such as St 3sp at temperatures up to 900°C. References 5: all Russian.

2415/13046
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PHYSICOMECHANICAL PROPERTIES AND STRUCTURE OF 03Cr11Ni10Mo2Ti PRECIPITATION-HARDENING MARTENSITIC STEEL AFTER AGING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 2 Apr 84) pp 84-87

[Article by P.A. Mironenko, T.A. Manko, S.I. Krasnikova and S.P. Pilipenko,
Dnepropetrovsk State University]

[Abstract] A study of 03Cr11Ni10Mo2Ti precipitation-hardening martensitic stainless steel (0.024% C, 10.40% Cr, 9.70% Ni, 2.00% Mo, 0.74% Ti, 0.16% Si, 0.09% Al, 0.09% Cu, 0.04% Mn, 0.01% Nb, 0.006% P, 0.004% S) was made, for the purpose of determining the changes in its structure and physicomechanical properties produced by aging at temperatures of 100-700°C for test periods of 1 h at each. Isochronous heat treatment at temperatures up to 500°C was found to increase the etchability without any other metallographic changes. Aging at 500-650°C was found to precipitate only globules of the cubic β -Ni₃Ti phase, with attendant changes in the martensite structure beginning at 600°C, austenite crystals becoming wider and martensite flakes becoming thinner with a buildup of a Widmanstätten structure at 650°C. Aging at 700°C was found to shape the austenite crystals into needles and to orient them along the martensite flakes, also to precipitate the γ -Ni₃Ti phase in the form of bar crystals with c.p.h. lattice. Maximum ultimate strength, 0.2% yield strength, and hardness were attained by aging at 500°C, after having been hardly at all increased by aging at temperatures up to 200°C. Aging at 500°C also decreased both plasticity and resilience to a minimum, however, after neither of them had been decreased by aging at temperatures up to 350°C. These results are interpreted in terms of two processes occurring simultaneously but having different effects, namely, stress relaxation caused by the martensite transformation and stress localization caused by unequal atomic volumes of the host phase and the precipitating phase. According to these results, the 450-550°C temperature range is most preferable for aging this steel. A study of the precipitation-hardening kinetics within this temperature range for periods ranging from 7.5 min to 24 h has established that optimum hardening of this steel is attainable by aging it in two stages, first at low temperature of 460-500°C for 1-2 h and then isothermally at 600°C within the ($\alpha + \gamma$)-phase range for 1 h after this higher temperature had been reached by heating at a rate of 20-60°C/min. References 4: all Russian.

2415/13046
CSO: 1842/133

NONFERROUS METALS AND ALLOYS: BRAZES AND SOLDERS

UDC 669.017:621.74.043

CHANGE IN ALLOYING OF SOLID SOLUTION OF ALLOYS IN THE SYSTEMS Al-Mg AND Mg-Al
UPON CRYSTALLIZATION UNDER PRESSURE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 23 May 84)
pp 86-90

[Article by T.N. Lipchin, Perm Polytechnical Institute, Department of
Casting Production]

[Abstract] Studies of the alloying of Al-Mg and Mg-Al alloys upon crystallization under pressure were performed on aluminum alloys containing 3.20, 5.80, 6.80, 9.20, and 12.20% Mg and magnesium alloys containing 1.20, 3.40, 5.20, 7.30, and 12.20% Al. Billets 40 mm in diameter were obtained by casting with crystallization under pressures of 0, 100, 200, 400 MPa in a mold with a temperature of 150-200°C. The cooling rate was 3-5°C/s at P=0, 8-10°C/s at P=100 MPa, 13-15°C/s at P=200-400 MPa in the melting point range. Castings were further cooled in air from 350-400°C. The experimental data obtained indicated a reduction in alloying of the solid solution with increasing pressure of crystallization. The concentration of the second component in the solid solution decreased by approximately 0.7-1.0% in the transition from P=0 to P=400 MPa, with corresponding increases in the intermetallic phases. The change in concentration of the alloying component in the solid solution results from the effect of pressure itself and the increased cooling rate as well. The influence of pressure is predominant in the alloys studied. References 13: all Russian.

6508/13046
CSO: 1842/121

UDC 669.292'782:621.039.531

HEAT CAPACITY OF THE COMPOUND V_3Si BOMBARDED BY FAST NEUTRONS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 5 Apr 85) pp 895-902

[Article by A.V. Mirmelsteyn, A.Ye. Karkin, V.Ye. Arkhipov and
B.N. Goshchitskiy, Metal Physics Institute, Ural Scientific Center, USSR
Academy of Sciences]

[Abstract] A study is presented of changes in the phonon spectrum of V_3Si upon fast neutron bombardment. The heat capacity of two V_3Si single crystals was measured before and after bombardment with $8 \cdot 10^{19} \text{ cm}^{-2}$ fast neutrons, and also after annealing for 30 minutes at 675, 775, and 875 K (specimen 1), and bombardment with $2.5 \cdot 10^{20} \text{ cm}^{-2}$ (specimen 2). All changes in T_c upon bombardment of V_3Si can be explained by the change in $N(\epsilon_F^c)$. Changes in phonon spectrum upon bombardment could not be detected due to difficulties in separating the electron and phonon contributions to the heat capacity of the initial specimen. References 19: 5 Russian, 14 Western.

6508/13046
CSO: 1842/115

UDC 669.295:620.184

INFLUENCE OF PLASTIC DEFORMATION AND HEATING RATE ON PHASE CONVERSIONS IN HARDENED VT32 ALLOY

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 12 Dec 84) pp 936-942

[Article by V.N. Gridnev, V.S. Ivaniy, O.M. Ivasishin and N.V. Sviridenko,
Metal Physics Institute, Ukrainian SSR Academy of Sciences]

[Abstract] A comparison is presented of the process of decomposition of the metastable β -phase in VT32 (Ti-3% Al-9% Mo-9% V-1% Cr-1% Fe) after hardening and additional deformation by rolling after hardening with various heat treatments, to determine the specifics of phase conversions produced by crystalline structure and texture defects. This decomposition may occur with the forming of intermediate α'' and ω phases or with direct liberation of the α phase. Excess vacancies are important in the formation of the ω phase, while internal stresses determine formation of the α'' phase. More rapid continuous heating to the isothermal processing temperature suppresses development of these intermediate phases. Cold plastic deformation of hardened VT32 suppresses formation of the ω phase but facilitates liberation of the α'' phase. When the undeformed β phase decomposes, BCC to HCP conversion develops, according to all possible variations, whereas anisotropic deformation hardening reduces the number of types of conversion during

subsequent deformation leading to the formation of a sharply delineated prismatic α phase texture. References 12: 10 Russian, 2 Western.

6508/13046
CSO: 1842/115

UDC 669.3'28:539.216.2:669-156

STRUCTURE OF RAPIDLY HARDENED FILMS OF Cu-Mo ALLOYS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 13 Dec 84) pp 943-947

[Article by A.I. Ilinskiy, M.Ya. Fuks, deceased, A.V. Arinkin, A.I. Zubkov and Yu.L. Bazarov, Kharkov Polytechnical Institute imeni V.I. Lenin]

[Abstract] A study is made of the physical properties and their relationship to the structure of vacuum Cu-Mo condensates whose components are not mutually soluble under equilibrium conditions. Studies were performed on nonannealed films about 50 μm thick obtained by joint condensation of copper and molybdenum vapors on a nonoriented glass ceramic substrate at 620 K. Specimens with up to 0.3 at.% molybdenum have a single-phase structure. Increasing molybdenum content results in the appearance of BCC inclusions of the metal in an FCC copper matrix. Studies of oriented microdeformation revealed a complex and nonmonotonic variation of inclusion size as a function of molybdenum concentration. Recrystallization is important in the process of forming the structure of these condensates; the axial texture changes with an increase in molybdenum concentration. The results of the study indicate the formation during condensation of the face-centered cubic lattice of a solid solution of substitution of molybdenum in copper. As the concentration of molybdenum is increased, partial decomposition of the solution occurs with the formation of oriented body-centered cubic molybdenum segregations. The studies show the possibility of producing alloys by very rapid hardening during vacuum condensation of elements which are not mutually soluble under equilibrium conditions. References 12: 11 Russian, 1 Western (in Russian translation).

6508/13046
CSO: 1842/115

UDC 669.295:621.78:669-176

INFLUENCE OF THERMAL CYCLING ON TEXTURE OF α -TITANIUM ALLOYS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 6 Feb 85) pp 955-959

[Article by D.A. Skryabin and R.A. Adamesku, Ural Polytechnical Institute imeni S.M. Kirov]

[Abstract] A study is made of the possibility of changing the texture in titanium-based alloys by thermal cycling. The studies were performed on

specimens of unalloyed titanium, as well as an alloy of titanium plus 3.58% aluminum. Specimens were placed in a furnace heated to 50°C above the temperature at which polymorphous conversion begins and held for 5 minutes, then periodically cooled to 600°C and once again heated to the original temperature. Thermal cycling produced a texture-free material at small degrees of compression or significantly reduced the initial texture at higher degrees of compression. References 7: all Russian.

6508/13046
CSO: 1842/115

UDC 669.24.26-194:620.182/.186

PHASE AND STRUCTURAL TRANSFORMATION UPON HIGH TEMPERATURE HEATING IN A COMPLEX NICKEL ALLOY

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 19 Mar 85) pp 960-967

[Article by V.P. Lesnikov, V.A. Kopylova, A.A. Kopylov, V.V. Poleva, T.M. Maslakova and V.V. Kiselev, Ural Polytechnical Institute imeni S.M. Kirov]

[Abstract] A study is presented of phase and structural transformation in a nickel-chromium-based alloy with a concentration of electron vacancies of less than 2.34 in the 800-900°C interval at stresses of 25-450 MPa. The alloy, containing cobalt, tungsten, titanium, aluminum, and molybdenum, was long-term strength tested in air and subjected to phase and x-ray structural analysis and electron-microscope studies of thin foils. During loading, finely dispersed M_2C carbides were liberated, the volumetric fraction of which reached its maximum at 800°C and 450 MPa. The quantity of $M_{23}C_6$ carbides increased during testing, particularly as a result of the breakdown of MC and M_6C at 800°C, 450 MPa, and 850°C, 300 MPa, respectively. The total volumetric fraction of Y' phase and carbides increased slightly during testing. Subgrain disorientation angles increased irregularly with increasing temperature, particularly at high-angle boundaries. References 14: 4 Russian, 10 Western (3 in Russian translation).

6508/13046
CSO: 1842/115

UDC 669.28'782:539.213:536.63

HEAT CAPACITY OF MASSIVE AMORPHOUS Mo_3Si

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 5 Apr 85) pp 1025-1028

[Article by A.V. Mirmelshteyn, A.Ye. Karkin, M.N. Khlopin and
V.Ye. Arkhipov, Metal Physics Institute, Ural Scientific Center, USSR
Academy of Sciences; Atomic Energy Institute imeni I.V. Kurchatov]

[Abstract] Measurements of heat capacity are performed in the 3-300 K interval on a massive specimen of Mo_3Si (about 17 g) bombarded with a fast neutron flux of $3 \cdot 10^{20} \text{ n/cm}^2$. After the bombardment, the specimen was annealed at 573-1173 K until its initial parameters were restored, then bombarded with a fast neutron flux of $3 \cdot 10^{20} \text{ n/cm}^2$. Heat capacity was measured on two different installations to obtain the greatest possible reliability. A tablet with a mass of about 5 g was cut from the original 17 g specimen and its heat capacity measured as well. The results of the two methods agree well with each other. The difference in absolute values of heat capacity is about 3-4%. Upon amorphization, γ is found to increase by a factor of 1.5, the low-temperature Debye temperature decreases significantly, the entire phonon spectrum is softened, particularly the low-frequency end. The behavior of the massive specimen is quite similar to the behavior of amorphous binary alloys. Although the density of electron states on the Fermi surface increases, the increase in $N(\epsilon_F)$ observed is insufficient to explain the change in T_c of the compound upon amorphization, whereas the phonon spectrum contribution predominates. References 9: 6 Russian, 3 Western.

6508/13046
CSO: 1842/115

UDC 669.85/.86:535.33/.34

$N_{4,5}$ -SPECTRA OF CHARACTERISTIC REFLECTED ELECTRON ENERGY LOSSES IN COMPOUNDS OF LANTHANUM AND CERIUM

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 5, Nov 85
(manuscript received 25 Apr 85) pp 1028-1030

[Article by Ye.Ya. Komarov, Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] $N_{4,5}$ -spectra of the characteristic losses of the energy of reflected electrons are obtained for lanthanum and cerium in a number of their compounds with oxygen and sulfur in order to determine the variation in structure of the spectra as a function of the nature of the chemical bond. Based on a comparison with calculated results, the lines in the

experimentally obtained spectra of metallic lanthanum were identified. In contrast to the spectra of lanthanum, the $N_{4,5}$ -spectra of metallic cerium changes significantly when it is oxidized. The clear difference in the spectra corresponding to the different valent states of the rare earth metal atoms may allow the method of spectroscopy of characteristic losses to be used to study compounds with mixed valence. References 10: 5 Russian, 5 Western.

6508/13046
CSO: 1842/115

UDC 669.3:539.3

SPECIFICS OF ALLOYING LIQUID COPPER WITH EXOTHERMIC ADDITIVES

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 28 Jun 84) pp 55-60

[Article by F.N. Streletsov and V.M. Klimov, Moscow]

[Abstract] An attempt is made to analyze the nature of the heat exchange upon alloying liquid copper with elements which form exothermic solutions with copper. For simplicity, the problem is stated in one dimension, with the liquid metal occupying the lower portion of the bath, the alloying substance being added to the top. The distribution of temperature over the depth of the bath is computed. Local superheating is found to be possible if the rate of dissolution of the substance is comparable to the rate of temperature equalization in the bath. The most significant factor influencing the process is the content of the alloying element in the substance added. Local superheating does not occur upon dissolution of alloying substances whose melting point is higher than the temperature at which alloying is performed. References 8: 5 Russian, 3 Western (1 in Russian translation).

6508/13046
CSO: 1842/114

UDC 537.533.2:621.38

THERMALLY-STIMULATED EXOELECTRON EMISSION OF THE SYSTEM Nb-Nb₂O₅

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 18 Oct 83) pp 115-118

[Article by A.M. Shkilko, V.V. Borisov, A.A. Kresnin and S.A. Sazonova, Kharkov]

[Abstract] A study is made of thermally-stimulated exoelectron emission from the surface of niobium and from films of Nb₂O₅ grown on a niobium surface after anodizing in a 5% aqueous H₃PO₄ solution. Film thickness varied from

72 to 250 nm. The possible zone of emission of exoelectrons from the specimens is evaluated to determine the nature of the centers responsible for the observed thermally-stimulated exoelectron emission. The results indicate a surface location for the major active centers in these systems.

References 13: 11 Russian, 2 Western.

6508/13046
CSO: 1842/114

UDC 669.14,669.295:620.193.16

BEHAVIOR OF TITANIUM AND STEELS EXPOSED TO CAVITATION EFFECTS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 12 Jan 84) pp 119-123

[Article by A.Ya. Grinberg, L.K. Gordiyenko and V.E. Volin, Moscow]

[Abstract] A study is presented of the kinetics of cavitation damage to TL-3 titanium, 20Kh13 stainless steel, and type 35 carbon steel in the stage of significant surface damage. Experiments were performed in a magneto-striction installation at the All-Union Scientific-Research Design and Technological Institute of Hydraulic Machine-Building with nonmoving specimens. The resonant frequency of the oscillations of the core of the electromechanical converter was about 20 KHz. Fractographic studies of specimen surfaces on a scanning electron microscope indicate the identical external appearance of damage to the materials tested. Viscous fracture was observed in all cases, indicating that a common three-stage fracture system is responsible, regardless of material structure. Comparison of cavitation resistance of structural materials of different types should thus be performed during the earlier stages of erosion, where more complete identification of specimen damage is possible. References 2: both Russian.

6508/13046
CSO: 1842/114

UDC 621.315.59:669.293

INFLUENCE OF HYDROGEN CONTENT IN NIOBIUM POWDER ON ELECTRICAL PARAMETERS OF ELECTROLYTIC CONDENSER ANODES

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 48-50

[Article by Yu.B. Patrikeyev, N.S. Vorobyeva, V.V. Badovskiy, O.A. Bakhtilina and A.S. Petukhova]

[Abstract] Ingots of high purity niobium were divided into parts and hydrogenated with purified hydrogen at pressure up to $1.0 \cdot 10^{-5}$ Pa, yielding specimens of NbH_x with various quantities of hydrogen. The hydrides were

ground in a niobium ball mill in an atmosphere of argon and dehydrogenated at 750°C in a vacuum of 0.133 Pa. The powder obtained and the anodes pressed and sintered from it were studied. A polychlorovinylacetate binder was used with a unit pressure pressure of 34.3 MPa and pressing density of 4.5-6 g/cm³. The anodes were sintered at 1930°C, $\nu = 30$ minutes. It is found that there is a correlation between the lattice parameter of niobium powder obtained from hydrides containing 0.68-0.9% hydrogen and the electric characteristics of the anodes: the specimens hydrogenated completely had less leakage current. Grinding of NbH_{0.9} and dehydrogenation yields powders consisting of an α -solid solution of hydrogen in niobium. In the anodes the lattice parameters vary from 0.3300 to 0.3303 nm. Leakage current can be significantly reduced with a hydrogen content of not over 0.002%. Above this value, hydrogen influences the structural state of the niobium, distorting the crystalline lattice and increasing the leakage current. References 4: 1 Russian, 3 Western.

6508/13046
CSO: 1842/112

UDC 669.715

INFLUENCE OF LITHIUM AND CALCIUM IMPURITIES ON PROPERTIES OF ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 62-63

[Article by A.S. Fedosov and A.V. Kurdyumov]

[Abstract] This literature review discusses briefly the reports published by Soviet and Western authors concerning the influence of the presence of calcium and lithium as impurities on the properties of aluminum alloys. Data presented show that Ca and Li in quantities of 0.005 to 0.1% have mainly a negative influence on the properties of aluminum alloys, indicating that their contents should be limited by various refining methods. Blowing of gases containing sulfur hexafluoride through the melt is widely used abroad to limit the content of Li in aluminum. Studies are needed to improve knowledge of the influence of these two elements on all the properties of aluminum alloys. References 14: 11 Russian, 3 Western.

6508/13046
CSO: 1842/112

UDC 621.762

USE OF NICKEL ALUMINIDE IN ELECTRIC CONTACT COMPOSITION

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 69-70

[Article by Ye.F. Anikeyev, N.D. Kolesnikov, B.S. Mitin and A.M. Rybalchenko]

[Abstract] NiAl has a favorable combination of conductivity and corrosion resistance. A study was performed to determine the erosion resistance,

physical-mechanical properties and workability of Ag-NiAl. The microstructure of several composites was studied. The results indicate that composites containing up to 15% NiAl have satisfactory properties and can be recommended as erosion-resistant contact materials with reduced content of silver for use in medium-current applications. References 3: all Russian.

6508/13046
CSO: 1842/112

UDC 546.65'56'22.(-819.24+682.24)

ALLOYS IN THE SYSTEM PbTe-Gd₂Te₃

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 9 Apr 84) pp 2090-2091

[Article by I.O. Nasibov, T.I. Sultanov, M.I. Murguzov, V.K. Valiyev and S.M. Alidzhanova, Azerbaijan State Pedagogical Institute imeni V.I. Lenin]

[Abstract] Alloys in the system PbTe-Gd₂Te₃ were synthesized on the PbTe side at 1300-1500 K. The PbTe-rich alloys are compact, light gray in color with a metallic shine. Specimens containing 20 mol.% Gd₂Te₃ or less are stable in the presence of water and oxygen of the air at room temperature. They are soluble in organic solvents, alkalis, but are decomposed by mineral acids. The alloys were heated in evacuated quartz ampules to 770 K for 600 hours to achieve equilibrium and then quenched in ice water. DTA showed that all effects on the heating curve were endothermic and reversible. Two endothermic effects were observed responding to the liquidus and solidus points. Microstructural studies show that alloys up to 4 mol.% Gd₂Te₃ were single phase. With increasing Gd₂Te₃ content, two-phase alloys are formed. Microhardness measured in etched sections was found to be 440 MPa for PbTe and 760 MPa for alloys containing 4 mol.% Gd₂Te₃ and corresponding to PbTe-based α -solid solutions. Microhardness is almost independent of composition at 5-20 mol.% Gd₂Te₃. This indicates that 4 mol.% Gd₂Te₃ dissolves in lead telluride at room temperature. References 3: 2 Russian, 1 Western.

6508/13046
CSO: 1842/120

UDC 620.172.24:620.173.3

INFLUENCE OF TEMPERATURE ON CRACK RESISTANCE OF ALLOY OF MOLYBDENUM PLUS 30% TUNGSTEN

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 85 (manuscript received 21 Jun 84) pp 40-43

[Article by Y.I. Uskov, A.V. Babak, A.P. Dyachkov and V.A. Platonov, Institute of Strength Problems, Ukrainian SSR Academy of Sciences]

[Abstract] The creation of tungsten-molybdenum composites by powder metallurgy methods has allowed optimization of the strength and ductility of materials over a broad range of temperatures. This work presents results of studies of the influence of temperature on the crack resistance of an alloy of molybdenum with 30% tungsten, as well as data on the crack resistance of technically pure molybdenum and tungsten obtained by powder metallurgical methods in the temperature interval of 20 to 1800°C. An extremum in the area of the viscous-brittle transition temperature is characteristic of the temperature dependence of the stress intensity coefficient of a molybdenum plus 30% tungsten alloy. The nature of the fracture of the alloy depends on temperature. At 20°C up to the viscous-brittle transition point, the fracture is unstable, while at temperatures above this point it occurs by stable development of a major crack. Preliminary high temperature annealing causes irreversible reduction of crack resistance of the alloy but does not influence the type of fracture. The viscous-brittle transition point is lower for the alloy than for technically pure tungsten. Crack resistance is higher at temperatures above the viscous-brittle transition point, making the alloy promising for use at up to 2000°C. References 14: 13 Russian, 1 Western (in Russian translation).

6508/13046
CSO: 1842/127

UDC 621.74.08

ULTRASONIC QUALITY TESTING OF CASTINGS OF COPPER-BASED ALLOYS

Moscow LITEYNAYE PROIZVODSTVO in Russian No 12, Dec 85 pp 20-21

[Article by Ye.S. Ivanushkin, candidate of technical sciences, K.I. Dvorkin, G.A. Kuleshova and Yu.S. Droboshevskiy, engineers]

[Abstract] A study was made of the possibility of locating internal casting defects in brass, aluminum, and bronze marine fittings by ultrasonic testing. The structure of ingots and castings of copper-based alloys has considerable anisotropy of the elastic properties and absorption, making ultrasonic testing difficult. Metallographic and acoustical studies were utilized to develop methods of ultrasonic quality testing for these castings. The influence of grain size and porosity on the ability to test for local internal defects and porosity was studied. A sonatest UFД-1 installation and

a Soviet RUP150/300 device were used in the testing. Instructions were developed for ultrasonic testing of copper-based alloy castings.

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CSO: 1842/128

UDC 661.55

NITRIDING OF TITANIUM IN ACTIVATED RAREFIED NITROGEN

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received 25 May 85) pp 30-33

[Article by I.N. Frantsevich, deceased, L.A. Grishnova, V.L. Tikush and K.A. Safaryan, Institute of Materials Science Problems, UkrSSR Academy of Sciences]

[Abstract] Treatment of metallic titanium with rarefied nitrogen for improvement of its wear resistance is considered, such a treatment being made more effective by activation of the nitrogen with a high-frequency electric discharge. The composition and the structure of the interaction layers as well as the kinetics and the mechanisms of this process were studied in an experiment with 99.9% pure titanium and 99.995% pure gaseous nitrogen. The titanium surface had a fine finish produced by polishing and then etching with $HNO_3 + HF$ concentrate. Treatment with active ionized nitrogen and, for comparison, with inert molecular nitrogen was performed over a wide temperature range of 300-800°C. While absorption of molecular nitrogen began at 500°C, without visible changes on the surface till 800°C and a film less than 1 μm thick appearing at that temperature, absorption of ionized nitrogen began already at 300°C with a corresponding increase of mass and a film appearing at 600-800°C. The color of the surface turned golden and became more intense as the temperature was raised. The surface film was in each case TiN, according to x-ray structural and phase analysis. The buildup of this film followed the parabolic law $x^2 = Kt$ (x - film thickness, t - time), indicating a diffusion process, at any temperature in the case of molecular nitrogen but only up to 600°C in the case of ionized nitrogen. In the latter case at temperatures above 600°C the very initial stage of nitriding was characterized by a linear buildup $x = K_{lin} t$ of this nitride film. Accordingly, while diffusion of nitrogen atoms limits the interaction of titanium and molecular nitrogen, the diffusion is preceded by formation of the TiN surface film and followed by annealing of this film during treatment with ionized nitrogen. Buildup of this film, accompanied by formation of an α -phase solid solution, occurs faster as the surface temperature is raised. References 4: 3 Russian, 1 Western.

2415/13046
CSO: 1842/134

ENTHALPY OF ATOMIZATION AND ENTHALPY OF FORMATION CHARACTERIZING
SEQUISULFIDES OF RARE-EARTH METALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received
9 Jan 85) pp 75-77

[Article by G.Sh. Viksman and S.P. Gordiyenko, Institute of Materials
Science Problems, UkrSSR Academy of Sciences]

[Abstract] A new technology has been developed for producing high-purity sesquisulfides of rare-earth metals, namely, by fusion after atomization. For a determination of the thermodynamic characteristics of the process, specifically the enthalpy of components atomization and the enthalpy of compound formation, measurements were made by a method accordingly more expedient than the conventional one: mass-spectrometry after complete isothermal vaporization under vacuum. Analysis of mass-spectra over the 28-400 amu range with 24-26 eV ionizing electrons at temperatures of 2190-2350 K inside the effusion chamber has established that the principal ingredients of the vapor are in each case atoms of the metal and molecules of its sulfide, with molecules of its oxide appearing during the initial stage of vaporization. The sought enthalpies characterizing the production of sesquisulfides of four rare-earth metals (La_2S_3 , Nd_2S_3 , Sm_2S_3 , Gd_2S_3) have then been calculated on the basis of the Hertz-Knudsen equation describing the vaporization kinetics and the Gibbs-Helmholtz equation describing the vaporization thermodynamics, with the vapor composition and the oxygen impurity content in sesquisulfides taken into account. The enthalpies of atomization and formation are, respectively, 2726 ± 30 kJ/mole and 1039 ± 35 kJ/mole for La_2S_3 (evaporating at 2348 K), 2514 ± 30 kJ/mole and 1034 ± 35 kJ/mole for Nd_2S_3 (evaporating at 2212 K), 2447 ± 30 kJ/mole and 1204 ± 35 kJ/mole for Sm_2S_3 (evaporating at 2193 K), 2754 ± 30 kJ/mole and 1134 ± 35 kJ/mole for Gd_2S_3 (evaporating at 2280 K). Specimens were synthesized and identified by A.A. Kamarzin at the Chemistry Institute, Siberian Department, USSR Academy of Sciences. References 7: 5 Russian, 2 Western.

2415/13046
CSO: 1842/134

POROSITY-DEPENDENCE OF MECHANICAL AND TRIBOTECHNICAL CHARACTERISTICS OF
POWDER COPPER IN HIGH-SPEED FRICTION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received
23 Nov 84) pp 83087

[Article by N.G. Baranov, L.I. Pugina, N.A. Krylova and V.V. Gorskiy,
Institute of Materials Science Problems, UkrSSR Academy of Sciences]

[Abstract] A study of powder copper under conditions of high-speed friction was made, the purpose being to evaluate the dependence of its tribotechnical and other mechanical characteristics on the porosity of the compact and thus determine its suitability for moving parts of electrical equipment operating in aggressive media. Cylindrical specimens 15 mm high and 15 mm in diameter were produced, some from raw PMS-N copper powder and some, after sieving, from its -250+160 grain size fraction. Tests were performed in the special IPM (Institute of Materials Science Problems) stand according to the "three bodies" scheme with three cylindrical specimens held against a disk made of 07Cr16Ni6 steel (37-41 Rockwell C hardness) and covering 15% of its face area. The disk was rotated so as to rub the bases of those cylinders for a period of 1800 s at a sliding velocity of 11 m/s under a pressure of 0.1 MPa. Impact strength and Brinell hardness were measured, as indicators of mechanical characteristics. The chemical composition of the surface film and particularly the concentrations of metals (Cu, Fe, Cr, Ni) in it were determined with a "Kameka" MS-46 x-ray spectral microanalyzer on the basis of the $K\alpha$ -radiation. The results reveal that the impact strength of compacts decreases appreciably but their hardness decreases only slightly with increasing porosity, the hardness of copper powder not depending on its grain size. The data on the wear rate Δ ($\mu\text{m}/\text{km}$) fit two $\Delta = Ae^{KQ}$ curves ($A = 0.116$ and $K = 0.075$ for raw powder, $A = 0.014$ and $K = 0.174$ for its -250+160 fraction) and thus approximately two corresponding $\Delta = A(1 + KQ + \frac{1}{2}K^2Q^2)$ curves. An increase of porosity Q from 10% to 35% will thus reduce the wear resistance appreciably, without significantly changing the friction coefficient, but will also increase the impact strength. The surface film, having an average microhardness of 2620 MPa, were found to contain 91.3 wt.% (83.3 atom.%) Cu, 4.4 wt.% (4.6 atom.%) Fe, 1.0 wt.% (1.1 atom.%) Cr, 0.3 wt.% (0.3 atom.%) Ni, and 2.9 wt.% (10.7 atom.%) O₂. References 11: 10 Russian, 1 Western.

2415/13406
CSO: 1842/134

NONMETALLIC MATERIALS

UDC 621.315.592

DEFOCUSING OF LASER RADIATION AND MECHANISM OF LIGHT-INDUCED CHANGES IN INDEX OF REFRACTION IN SILICON

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 22 Mar 85) pp 2931-2935

[Article by R. Baltrameynas, D. Veletskas and I. Kapturauskas, Vilnyus State University imeni V. Kapsukas]

[Abstract] Uncompensated single crystals of n- and p-silicon doped with phosphorus or boron as well as pure single crystals were studied. Plates 320-360 μm thick were studied at 200-420 K. Single-photon excitation of the crystals was performed using laser radiation (neodymium laser, wavelength 1.064 μm , maximum power 10.0 MW/cm^{-2} , minimum pulse length $18\pm 1 \text{ ns}$). Defocusing of the laser beam is observed in all doped crystals, though the effect varies widely. Defocusing is not observed in pure crystals at less than 1 MW/cm^{-2} . The results indicate an unknown, effective mechanism of changing the index of refraction in silicon, related to concentration of nonequilibrium carriers in bands. The mechanism may involve changes in the charge of small impurity states with an increase in the level of excitation of the crystal. The results indicate that the Δn modulation in Si crystals may result from a change in the degree of filling small impurity states at depth $\Delta E_1 \leq 0.16 \text{ eV}$ from the corresponding allowed band. References 15: 9 Russian, 6 Western (2 in Russian translation).

6508/13046
CSO: 1842/113

UDC 539:67:621.315.592

INFLUENCE OF SILICON SURFACE PROCESSING ON LOW TEMPERATURE INTERNAL FRICTION

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 8 Jan 85) pp 98-101

[Article by V.S. Postnikov, V.I. Kirillov, Yu.A. Kapustin and V.S. Borisov,
Voronezh]

[Abstract] A study is made of low temperature internal friction in silicon single crystals after mechanical working of the surface or its oxidation in the process of high temperature annealing. Silicon specimens bombarded with neutrons were also studied to identify defects. Some of the specimens after grinding or immediately after cutting were polished with diamond paste to a depth of $2\text{-}3\cdot10^{-6}$ m (processing 1), others to a depth of $3\cdot10^{-5}$ (processing 2). Some specimens for neutron bombardment were ground to a depth of 10^{-4} m, then polished with diamond paste to a depth of $3\cdot10^{-5}$ m (processing 3). Some specimens were annealed in air at 1250°C for 8 to 10 hours, then rapidly removed from the furnace and placed on a block of silicon to achieve rapid cooling, and the oxide formed on the surface was removed by etching in hydrofluoric acid (processing 4). Secondary defects or A-centers were formed in the surface-deformed layers of all specimens. The A-centers have the same kinetic reorientation parameters in both n- and p-type silicon. References 14: 9 Russian, 5 Western.

6508/13046
CSO: 1842/114

UDC 670.026:686.4:620.179.4

EFFECTIVENESS OF SURFACE PROCESSING OF POLYIMIDE FILM IN VARIOUS GLOW DISCHARGE ZONES

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 20 Mar 85) p 124

[Article by L.M. Anishchenko, S.Ye. Kuznetsov and S.Yu. Lavrenyuk, Moscow]

[Abstract] Results are presented from a comparison of the effectiveness of processing of polyimide film in the positive column and negative glow areas of a glow discharge. Processing quality was evaluated on the basis of the magnitude of the adhesion of the atomized coating. The variation of adhesion as a function of glow discharge power was also studied. The experiment showed that treatment of a polyimide film in the positive column area leads to an increase in adhesion of the coating by a factor of 3 to 8 in comparison to adhesion on untreated specimens. The maximum increase in adhesion was observed at the least glow discharge power. References 2: both Russian.

6508/13046
CSO: 1842/114

UDC 666.17.031

INFLUENCE OF LITHIUM-CONTAINING WASTES ON MANUFACTURE OF BOTTLE GLASS

Moscow STEKLO I KERAMIKA in Russian No 12, Dec 85 pp 6-7

[Article by K.S. Katkova, engineer, Yu.A. Guloyan, doctor of technical sciences, T.I. Balandina, A.G. Belyayeva and E.P. Seregina, engineers, Gusev Branch, State Scientific Research Institute of Glass]

[Abstract] Results are presented from studies of lithium-containing mica wastes from beneficiation plants as glass-making intensifiers. The possibility was studied of using these wastes in the manufacture of green and pale-green sodium-calcium-silicate glasses. A combination of physical methods was used to study the influence of the wastes on processes of melting of the charge, silicate and glass formation, and clarification of the molten glass. Introduction of the lithium-containing wastes was found to decrease the temperature of drop formation and the flow point significantly, as well as increase the speed of complete melting by 1.7-4.8 times, primarily by significantly reducing the drop flow temperature. Charges containing 6.5-13 kg of mica waste per 100 kg of glass had the best characteristics. The number of bubbles in specimens was reduced, bubble size increasing from 0.1 to 0.8-1.0 mm. Up to 0.15% Li₂O can be introduced into pale-green glasses and up to 0.2% into green glasses. References 2: both Western.

6508/13046
CSO: 1842/118

UDC 666.124:546.65

EFFECTIVE UTILIZATION OF RARE-EARTH COMPOUNDS IN PRODUCTION OF STANDARD GLASSES

Moscow STEKLO I KERAMIKA in Russian No 12, Dec 85 pp 7-8

[Article by V.A. Fedorova, candidate of technical sciences, Gusev Branch, State Scientific Research Institute of Glass]

[Abstract] The author's institute has studied the combined influence of the addition of small quantities of rare-earth compounds on the process of clarification and decoloring of standard glass types. The clarifying influence of cerium dioxide is more complex than that of arsenic oxide, producing fewer bubbles in the initial period but yielding slower clarifying action during later periods. The rare-earth oxides of neodymium and erbium can be used as physical decoloring agents. Expansion of the areas of application of rare-earth oxides have posed the problem of more effective utilization of these substances in coloring of glass. New cerium-containing raw materials can be used to produce only green, blue, and smoky glass. The content of cerium dioxide should be increased in yellow and orange glass to obtain more saturated colors. References 5: all Russian.

6508/13046
CSO: 1842/118

UDC 666.112.8:666.117.9

USE OF NATURAL RAW MATERIAL TO PRODUCE PHOTOCHROMIC GLASS

Moscow STEKLO I KERAMIKA in Russian No 12, Dec 85 pp 12-13

[Article by V.I. Kiyan, engineer, V.F. Solinov and M.V. Artamonova, doctors of technical sciences, Moscow Chemical Technology Institute imeni D.I. Mendeleyev]

[Abstract] A study is presented of the possibility of using natural raw materials as replacements for soda and alumina in the production of photochromic glasses. Sodium-aluminum borosilicate glasses containing 50-72% SiO_2 , 2-15% Al_2O_3 , 3-20% Na_2O , 10-25% B_2O_3 were studied. Light-sensitive additives used were Cu_2O , CdO , NaCl , SnO , and Na_2SiF_6 . The glasses synthesized have good transparency after heat treatment and a rather high degree of darkening after UV irradiation. Transparency decreases with an increasing content of iron oxides due to appearance of a yellow coloration. In high-alkali photochromic glasses as iron oxide content increases, opalescence occurs and photochromic properties deteriorate. Relaxation rate decreases with increasing iron content. References 3: all Russian.

6508/13046
CSO: 1842/118

UDC 666.293

PROTECTIVE PROPERTIES OF PRIMERLESS ENAMELS

Moscow STEKLO I KERAMIKA in Russian No 12, Dec 85 pp 14-15

[Article by I.B. Alikina, candidate of chemical sciences, and A.A. Sirotinskiy, candidate of technical sciences, All-Union Scientific Research Institute for the Construction of Mainline Pipelines]

[Abstract] The Penzavodprom Production Association is now producing enameled pipe for construction of reclamation systems using primerless technology. This article presents a study of the protective properties of primerless enamel coatings, determining their resistance to heat, impact, and chemicals. Tartaric acid was found to be the most corrosive for the enamels, acetic acid the least corrosive. Tests in oxalic acid were interrupted due to a gain in the mass of the specimens, probably caused by formation of insoluble alkaline earth metal oxalates on the surface of the enamel. Corrosion in NaCl and Na_2SO_4 solutions at the boiling point was also studied, 3% NaCl being most corrosive due to the presence of the chlorine ion. The thermomechanical properties were found to be satisfactory for long-term use. References 2: both Russian.

6508/13046
CSO: 1842/118

COMPOSITION MULLITE-CONTAINING ENAMEL FOR CHEMICAL APPARATUS

Moscow STEKLO I KERAMIKA in Russian No 12, Dec 85 pp 15-16

[Article by Yu.D. Barinov, doctor of technical sciences, deceased, N.F. Smakota, N.V. Ivanov, candidates of technical sciences, and L.G. Shatalova, engineer, Dnepropetrovsk Chemical Technology Institute; Khimmash Plant, Poltava]

[Abstract] An enamel coating with increased thermal stability was produced using an acid-resistant enamel plus synthetic mullite. Mullite was selected as the filler because it is a refractory material, does not decompose in the temperature interval of roasting and utilization of silicate enamel coatings. It is resistant to all acids and alkalis and does not interact chemically with liquid glass, has good mechanical characteristics, and its coefficient of thermal expansion is comparable to that of glass. It is found that both mullite and quartz sand, when introduced to the grinding process, improve the thermal stability of the composite product, mullite by 120-160°C, sand by 20-40°C. Mullite slightly decreases the chemical stability of the enamel, but could still be used for chemical apparatus. References 5: all Russian.

6508/13046
CSO: 1842/118

SYNTHESIS AND PROPERTIES OF ALUMINUM-YTTRIUM-ZIRCONIUM OXIDES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 26 Mar 84) pp 2056-2058

[Article by S.V. Kalabukhova, Yu.L. Krasulin, deceased, A.V. Shoytova, V.A. Tumanov and Ye.N. German]

[Abstract] A study is made of crystallization in the three-component system $\text{Al}_2\text{O}_3-\text{ZrO}_2-\text{Y}_2\text{O}_3$ in a ratio of 54.5/38.7/6.8 mass.% in a ceramic obtained by hot pressing of calcined powders. The temperature dependence of strength in three-point flexure of the materials with and without addition of Mo and MoSi_2 is studied. It is found that crystallization of ternary aluminum, zirconium, and yttrium hydroxides passes through a stage of separation of imperfect microcrystals of zirconium dioxide from the radiographically amorphous aluminum oxide matrix. As the powders are heated, their specific surface reaches its maximum at 600-700°C. The ceramic material loses little strength with increasing temperature up to 1500°C. Addition of 5 to 10 mass.% Mo and MoSi_2 increases strength at room temperature. At elevated temperatures the strength loss is greater, particularly above 800-1000°C. References 8: 7 Russian, 1 Western.

6508/13046
CSO: 1842/120

PRODUCTION OF CaLnAlO_4 CRYSTALS BY THE CHOKHRAISKIY METHOD

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 95
(manuscript received 19 Mar 84) pp 2069-2071

[Article by Z.S. Appen, A.Ya. Valtere, A.M. Korovkin, R.M. Rakhmankulov, A.Yu. Romanov and Yu.P. Udalov, Silicate Chemistry Institute imeni I.V. Grebenshchikov, USSR Academy of Sciences; State Optics Institute imeni S.I. Vavilov]

[Abstract] Initial charges were obtained by solid phase synthesis from mixtures of CaCO_3 , Al_2O_3 , and Ln_2O_3 powders, heated in air at 1570 K for 20 hours. Crystals were grown from iridium crucibles in argon in a high frequency heating installation with oxygen partial pressure in the growth chamber controlled at 10^{-2} - 10^{-5} Pa. At partial pressures of oxygen over 10^{-2} Pa, the melt is saturated with oxygen, while at below 10^{-5} Pa, reactions occur leading to a decrease in oxygen concentration. This influence of partial oxygen pressure results from incongruent evaporation of oxides from the melt and the formation of defects related to the excess or shortage of oxygen in the lattice. Twining in the (100) plane is observed, related to cellular growth of CaLnAlO_4 due to concentration supercooling. References 6: 5 Russian, 1 Western.

6508/13046
CSO: 1842/120

PREPARATION

WORK ON SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS PROCESSES DESCRIBED

Yerevan KOMMUNIST in Russian 31 Dec 85 p 2

[Article by Professor A. Merzhanov, chairman of USSR State Committee for Science and Technology Scientific Council on the problem "The Theory and Practice of Self-Propagating Synthesis Processes," recipient of the Armenian SSR State Prize, and A. Nalbandyan, director of the Armenian SSR Academy of Sciences Physical Chemistry Institute, recipient of the Armenian SSR State Prize and academician of Armenian SSR Academy of Sciences: "SPHTS-Process"; passages enclosed in slantlines printed in boldface]

[Text] Self-propagating high-temperature synthesis (SPHTS) is a modern technology. With the aid of the rapid combustion reactions that occur in various chemically-active media, it enables one to produce valuable inorganic substances and materials. In the most advanced processes, items (parts) with predetermined shape and dimensions and having the required set of properties are synthesized in one step from chemical reagents. The SPHTS method is based on a remarkable principle of technological combustion. According to this principle, the heating of a substance for the carrying out of a high-temperature process proceeds /spontaneously/ due to the rapid liberation of the heat of the chemical reaction. The heating does not require expenditure of electric power. Owing to the high combustion rates, SPHTS technologies are very intensive. Thus, they ensure a high labor productivity. It is of no small importance that most SPHTS processes /produce little or no waste/ and are ecologically clean. They are very diverse in terms of technology. Today various powders of inorganic compounds for sintering of articles, spraying, and for use as abrasives are synthesized on their basis. Methods have been developed for direct production of articles--hot combustion products either are themselves sintered while retaining their previously given shape or are subjected to compaction or plastic deformation. A melt forms in the higher-temperature processes. It can be cast into a given mold and crystallized. Both thick (hard-facing) and thin protective coatings can be applied by means of synthesis. One can join high-temperature, difficult-to-weld materials and impregnate porous bodies. SPHTS offers great promise in the production of large parts. As a rule, its products are of high quality. Their use in the national economy (yes, their production also) /leads to savings of materials/. One can also mention that significant capital expenditures are not required for the creation of SPHTS production units, because the process itself performs many

operations in this technology. Various products can be obtained within the framework of a single technological solution. Thus, practical utilization of the SPHTS processes yields not only technological but also economical benefits. Wide industrial adoption of this progressive process as a resource conservation technology with great possibilities can become an important stage in the acceleration of scientific and technical progress. Therefore, it is not an accident that interest in the SPHTS process is being shown around the world.

This modern technological method came into being in 1967 as a result of a discovery by scientists of the USSR Academy of Science Physical Chemistry Institute. Its scientific foundations were worked out in the subsequent years. They made it possible to develop methods for controlling the rate, temperature, and completeness of the processes and the material's composition and structure and also to carry out various pilot-scale developments. Gradually, SPHTS has become a new and promising scientific and technical area. A scientific council on the problem "The Theory and Practice of Self-Propagating High-Temperature Synthesis Processes" operates for the organization and coordination of fundamental and applied research in this area in the USSR State Committee for Science and Technology. An All-Union scientific and technical program aimed at the industrial adoption of SPHTS was developed for the 11th Five-Year Plan. As a result of the fulfillment of the program, our country is the first in the world to have made operational SPHTS-based high-efficiency industrial production units for a number of valuable ceramic powders. These production units are now in operation in Kirovakan, Baku, Zaporozhe, Makeyevka, and other cities. The industrial output of new abrasive pastes KT and KTIOL, the principal component of which is SPHTS titanium carbide, has been set up.

Nitrided ferrovanadium, an important master alloy for the making of high-speed and cold-resistant steels, is now produced on the industrial scale. The introduction of SPHTS processes into the national economy has already produced savings of more than 150 million rubles. It has resulted in high unit resource economy. Various forms of SPHTS are used in pilot-scale production of a great variety of products such as tungsten-free hard-alloy parts (cutting blades, rolls, drawplates, dies), ceramic electrical insulators, refractory crucibles, silverless breaker contacts, hard-faced plowshares, ceramic and cermet pipes, and many other articles. Industrial mastery of production is planned for the 12th Five-Year Plan; its economic indices will be quite high. The annual savings are expected to be 7-8 times the capital expenditures. The development of SPHTS is planned in various regions of the country.

Armenia plays an important role in the SPHTS problem. Since 1972, Armenian scientists have successfully worked on scientific and technological investigations of the SPHTS processes. The Armenian SSR Academy of Sciences Physical Chemistry Institute was the first /to discover the possibility of the combustion of metals in hydrogen with the formation of thermally unstable hydrides/. An effective technology for the hydrogenation of metals and alloys has been developed on the basis of SPHTS. Hydrides are accumulators of /hydrogen--the fuel of the future--/ and are used as catalysts in many

chemical processes. It was precisely in Armenia that SPHTS was used for the first time on the industrial scale. The Kirovakan High-Temperature Heater Plant was the first in the country to abandon the furnace technology and to master the SPHTS process for the production of molybdenum disilicide, having demonstrated the benefits of the new technology.

Original SPHTS processes have been proposed at the "Kamen i Silikaty" [Stone and Silicates] Scientific-Production Association for the synthesis of silicon nitride and carbide and of some composite materials using Armenian minerals (tufa, perlite, and diatomite) as raw materials.

A special design-technological bureau for refractory materials has been established at the Armenian SSR Academy of Sciences Physical Chemistry Institute. It has done a lot to promote SPHTS production. The republic has the skilled personnel--the large number of candidates of sciences working on the SPHTS problem. Several doctoral dissertations are ready for defense.

However, in spite of obvious successes, the pace with which SPHTS is being adopted leaves much to be desired. It would be nice if the interested republic ministries and industrial enterprises would join in as soon as possible in the introduction of the latest technologies developed both at the Armenian SSR Academy of Sciences Physical Chemistry Institute and elsewhere in the country.

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CSO: 1842/129

UDC 669.2.017

STRUCTURE, PHASE COMPOSITION AND MECHANICAL PROPERTIES OF CASTING ALLOY
Al + 7% Mg + 3% Zn WITH THE ADDITION OF IRON AND BERYLLIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 6 Jul 84)
pp 71-77

[Article by N.A. Belov, Yu.V. Yevseyev and V.S. Zolotorevskiy, Moscow
Steels and Alloys Institute, Department of the Physical Metallurgy of
Nonferrous, Rare and Radioactive Metals]

[Abstract] Based on previous studies by the same authors, the influence of the addition of up to 1.5% Fe and up to 1% Be on the structure, phase composition, fracture toughness, and mechanical properties under tension of an alloy of Al + 7% Mg + 3% Zn was studied. The alloy specimens were made in an electric resistance furnace in graphite-chamotte crucibles. Analysis of the structure of the alloys studied is used to construct the distribution of phase areas in the Al-Mg-Zn-Fe-Be system with 7% Mg and 3% Zn. Comparison of the results of the structure-phase analysis with mechanical properties allows development of a semiquantitative model of the change in mechanical properties in the alloy as a function of Fe and Be content. Two trinary (Al, Fe, Be)-containing phases are found with a Be:Fe ratio close to 0.5 and 0.8-0.9. The type of Fe-containing intermetallides significantly influences the mechanical properties. Small particles of the phase Fe₂Al₄Be₅ of eutectic origin are most favorable. References 8: 5 Russian, 3 Western (1 in Russian translation).

6508/13046
CSO: 1842/121

UDC 621.74.002.6Δ65.011.56

COMPUTER-AIDED DESIGN OF OPTIMUM CASTING TECHNOLOGY

Moscow LITEYNAYE PROIZVODSTVO in Russian No 11, Nov 85 pp 5-7

[Article by G.F. Velikanov, candidate of technical sciences, I.N. Primak, candidate of technical sciences, V.V. Desnitskiy, candidate of technical sciences, and A.P. Rusinov, engineer]

[Abstract] The casting technology at the Nevskiy Zavod Production Association must ensure the proper density of ingots with the optimum sprue system based on the hydrodynamic characteristics of the mold filling process, optimum pouring conditions, prevention of hot cracking, stress relief during the cooling period, and, ultimately, adequate dimensional precision of ingots. Design of the optimum pouring operation has already been computerized in the dialog mode, as one subsystem of a computer-aided design system, and this subsystem is now used at the plant. The input data here include grade of steel and pertinent parameters such as volume shrinkage and superheat temperature, method of metal feed and duration of mold filling process, thermal properties of the solidifying steel melt mixed with slag, dimensions of risers and direction of their slope, allowable porosity factor as measure of required ingot density, and geometrical characteristics of ingots. The next step will be computerization of the second subsystem, for prevention of hot cracking. Participating in the research and the programming of design algorithms were engineers G.M. Kreymerman, V.P. Badayeva, S.I. Rybachuk, V.F. Koreshkov, and M.A. Druzhevskiy. References 3: all Russian.

2415/13046
CSO: 1842/110

UDC 621.746.42:658.512

COMPUTER-AIDED DESIGN OF CASTING TECHNOLOGY FOR LIGHT ALLOYS

Moscow LITEYNAYE PROIZVODSTVO in Russian No 11, Nov 85 pp 13-15

[Article by A.A. Neustruyev, doctor of technical sciences]

[Abstract] Computer-aided design of the casting technology for light alloys is described and analyzed, a system for this purpose having been developed by the Moscow Aviation Technological Institute jointly with the Andropov Aviation Technological Institute and several industrial enterprises. The system includes data search with echeloning of answers in a dialog mode of operation. The pouring system is designed and the problem of ingot solidification is solved by the method of grids, in accordance with the Fourier equation of heat conduction. The algorithms have been constructed and programmed so as to apply to the specifics of casting light metals or alloys such as aluminum into ingots of various shapes such as angle brackets, channel beams, or I-beams. Participating in the development of the computer-aided

design system were G.L. Khodorovskiy, doctor of technical sciences, V.S. Makarin, candidate of technical sciences, V.P. Pantyukhin, candidate of technical sciences, Ye.B. Glotov, candidate of technical sciences, Yu.P. Matveyko, candidate of technical sciences, V.V. Chistyakov, candidate of technical sciences, V.S. Moiseyev, engineer, V.A. Tokarev, engineer, V.I. Dankov, engineer, and A.Yu. Dorofeyev, engineer. References 5: all Russian.

2415/13046
CSO: 1842/110

UDC 621.74.043Δ65.011.56

DIALOG SOFTWARE FOR OPTIMIZATION OF PRESSURE CASTING PROCESS

Moscow LITEYNAYE PROIZVODSTVO in Russian No 11, Nov 85 pp 19-20

[Article by A.A. Kreytser, candidate of technical sciences, G.B. Dyatlenko, engineer, M.V. Khazanov, engineer, and P.E. Kheruntsev, candidate of technical sciences]

[Abstract] One part of the three-level automatic control system developed by the NIISL for pressure casting contains the AKTIV dialog software, a set of programs for optimizing the process, which is also a part of the computer-aided design system for pressure casting technology. The input data have been reduced to seven influencing factors which essentially determine the process and nine indicators which completely characterize the ingot quality. The optimization problem is solved by statistical analysis of process data obtained in series of experiments, using the saturated Baux-Draper second-order mathematical model, by convolution with the aid of the Harrington function for calculation of the generalized optimization parameter, and by subsequent steepest descent. The entire AKTIV software is being tested at a casting plant in Odessa.

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UDC 621.74.04:621.74.08

USE OF COMPUTERS IN CONTROL SYSTEMS FOR CASTING PROCESSES AT THE VOLGA AUTOMOBILE PLANT

Moscow LITEYNAYE PROIZVODSTVO in Russian No 11, Nov 85 pp 30-32

[Article by P.G. Chechushkin, engineer, and T.B. Gorevanova, engineer]

[Abstract] An automatic control system has been under development since 1977 for the technological processes of iron casting at the Volga Automobile Plant. The latest stage of this development is conversion from local control

loops operating with relay logic to broader control loops on a computer base. One such system is being constructed for automatic control of the mixture preparation process, a two-level system using two SM small computers. Another such system is being constructed for automatic control of the melting process in the three 40 t electric-arc furnaces and the four 25 t, 50 t induction furnaces, as well as of the subsequent sacking process in 11 other furnaces, with minicomputers and microcomputers for each furnace optimizing its performance in either the analog mode or the control mode as directed from a central computer and also convertible to control by human operator.

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CSO: 1842/110

UDC 621.74:658.2

AUTOMATED CONTROL OF CASTINGS PRODUCTION

Moscow LITEYNNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 32-33

[Article by A.I. Fuks, candidate of technical sciences, I.G. Yaskovskiy, candidate of technical sciences, V.S. Krivitskiy, candidate of technical sciences, V.G. Markovnikov, candidate of technical sciences, and M.V. Machevskiy, engineer]

[Abstract] Production of castings is controlled at three levels: industry-wide, plant-wide, and shop-wide. Control is based on a mathematical-economic model at each level. Control involves forecasting, planning for a given 5-year period, and planning for the current year. Planning includes calculations of demand, production volume, and shop capacity. All these calculations and thus the entire planning can now be done by a YeS computer using the appropriate applied program package so that control of castings production becomes automated. Participating in the work were engineers K.N. Smirnov, L.A. Tsyvkin, L.E. Blokh, I.Kh. Feygin, V.V. Milevskaya, L.N. Kostrov, and T.V. Khanovich. References 5: all Russian.

2415/13046
CSO: 1842/110

UDC 539.87

RADIATION MIXING AND ITS INFLUENCE ON THE STRUCTURE OF SOLIDS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 3 Jul 84) pp 3-6

[Article by V.T. Zabolotnyy, V.P. Babayev and K.P. Gurov, Moscow]

[Abstract] An estimate is presented of the contribution of radiation mixing to changes in the structure of solids exposed to radiation. It is assumed

loops operating with relay logic to broader control loops on a computer base. One such system is being constructed for automatic control of the mixture preparation process, a two-level system using two SM small computers. Another such system is being constructed for automatic control of the melting process in the three 40 t electric-arc furnaces and the four 25 t, 50 t induction furnaces, as well as of the subsequent soaking process in 11 other furnaces, with minicomputers and microcomputers for each furnace optimizing its performance in either the analog mode or the control mode as directed from a central computer and also convertible to control by human operator.

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Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 3 Jul 84) pp 3-6

[Article by V.T. Zabolotnyy, V.P. Babayev and K.P. Gurov, Moscow]

[Abstract] An estimate is presented of the contribution of radiation mixing to changes in the structure of solids exposed to radiation. It is assumed

that the movement of an atom driven out of one position to another occurs in a straight line but in a random direction. The combined influence of radiation mixing and radiation-reinforced and thermal diffusion on the structure of solids and their composites is studied. The formation and growth of pores upon irradiation results from radiation-reinforced diffusion, which leads to decomposition of a supersaturated solution of nonequilibrium vacancies. Radiation mixing causes equalization of concentration irregularities and prevents the development of accumulations of point defects. The examples presented indicate the possibility of using the calculation method suggested to determine the influence of radiation mixing on the structure of solids and for the solution of various practical problems of radiation material science and ion-implantation technology. References 13: 4 Russian, 9 Western (1 in Russian translation).

6508/13046
CSO: 1842/114

UDC 535.211

INFLUENCE OF RADIATION POWER FLUCTUATION ON LASER HARDENING

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 22 Dec 83) pp 12-16

[Article by V.S. Mayorov, Moscow]

[Abstract] Using a continuous LT1-2 laser as an example, radiation instabilities, their type and major causes are analyzed, and an estimate is given of the influence of these fluctuations on the process of laser thermal hardening without disrupting the initial surface smoothness (without melting), as well as recommendations for hardening conditions. Radiated power was measured with the use of a liquid nitrogen-cooled photoresistor. The most dangerous power fluctuations are those at low audio frequencies. Fluctuations may be caused by instability or pulsations in the discharge current, turbulence in the gas stream, instability of the optical resonator, thermal deformations in optical elements or instability of the gas composition of the laser medium. This article studies the influence of vibration on the operation of the installation. The conditions of hardening without melting depend greatly on the time structure of the laser radiation. Ignoring power fluctuations may cause significant variations between experimental and calculated results. The equations derived in this article can be used for periodic pulse lasers or laser radiation scanners as well. References 5: all Russian.

6508/13046
CSO: 1842/114

UDC 548.5

STABILITY OF SHAPE OF A CRYSTAL GROWN BY THE CHOKHRALSKIY METHOD

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 30 Jul 84) pp 66-70

[Article by I.N. Belokurova, D.M. Khavzhu and A.V. Kopyl, Moscow]

[Abstract] The basic relationships among growth parameters determining the shape of a growing crystal, i.e., relationships between crystal diameter at the leading edge of crystallization, crystal surface slope angle at the leading edge of crystallization to the axis of the crystal, and rate of movement of the leading edge of crystallization, are used to construct a mathematical model of crystal growth by the Chokhralskiy method. The model developed is applicable to crystals with diameters greater than about one centimeter. For these crystals, the crystal shape is asymptotically stable, indicating that the Chokhralskiy method has a mechanism of inherent self-regulation of the crystal shape. An analytic criterion indicating the presence of oscillations in crystal diameter is produced. Numerical solutions are obtained representing the variation in crystal diameter as a function of time for various rates of drawing of the crystal from the bath and various initial growth conditions. The constants of the mathematical model are determined experimentally by growing of germanium single crystals on a laboratory installation. References 7: 4 Russian, 3 Western.

6508/13046
CSO: 1842/114

UDC 539.4.01:669.27

HIGH TEMPERATURE STRENGTH OF ALLOYS IN THE SYSTEMS $W-Me_{n,m}^0$ and $W-MeC-Me_{n,m}^0$
PREPARED BY POWDER METALLURGY METHODS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 21 Nov 84) pp 81-86

[Article by K.B. Povarova, V.K. Kharchenko, M.A. Khmelkova, P.V. Makarov,
Ye.K. Zavarzina, V.V. Bukhanovskiy, B.I. Olshanskiy, A.B. Olshanskiy and
V.N. Spirin, Moscow]

[Abstract] The authors have established by analyzing data presented in previous works that at sintering temperatures, carbides are thermodynamically unstable and are oxidized by the oxygen adsorbed in the powder forming more stable metal oxides. This work has as its purpose the production of an alloy of tungsten by powder metallurgy with carbide hardening and a comparative study of the high temperature strength of powder metallurgy tungsten alloys with carbide and oxide hardening. Formation of carbide alloys required prevention of oxidation of the carbides during sintering by creating conditions allowing the equilibrium among HfC , O_2 , and C to shift into a lower

temperature area by introducing additional quantities of free carbon into the reaction zone. The possibility is demonstrated of producing alloys with carbide and combined carbide-oxide hardening with superior strength properties in comparison with unalloyed powder metallurgy tungsten and oxide-hardened tungsten alloys in the entire temperature range studied, 1500-2750°C. The greatest strength increase is observed at 1500-1800°C, the aging temperature, resulting from inhibition of thermally activated recrystallization processes. The increase in strength of oxide alloys is an order of magnitude less than that of carbide alloys. References 17: 12 Russian, 5 Western.

6508/13046
CSO: 1842/114

UDC 536.4:669.27

INTRODUCTION OF DISPERSED CARBIDES AND OXIDES INTO TUNGSTEN OBTAINED BY POWDER METALLURGY METHODS AND LOW TEMPERATURE PROPERTIES OF THE ALLOYS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 30 Apr 85) pp 87-93

[Article by K.B. Povarova, M.A. Khmelkova, P.V. Makarov, Ye.K. Zavarzina, V.K. Ushakov and A.B. Olshanskiy, Moscow]

[Abstract] The purpose of this work was to study the nature of the influence of microadditives of a number of oxygen-active elements and of hardening phases on the structure and properties in the temperature interval of the tough-brittle transition of deformed powder metallurgical tungsten alloys. Deoxidizing elements used in this work to facilitate removal of oxygen from powder metallurgical tungsten during sintering were boron and carbon, which have low oxide evaporation temperatures. Two groups of model alloys were prepared: alloys with oxides in which boron was used as the deoxidizer and those with carbides in which carbon was additionally added to bond the free oxygen and prevent oxidation. Under identical conditions of deformation, alloys with carbides have more fragment fine structure with greater deformation contrast at the boundaries. Introduction of carbides can increase the strength of powder metallurgical tungsten in the temperature range of interest by 20 to 40%, primarily due to more intensive deformation hardening of these alloys. References 21: 18 Russian, 3 Western (2 in Russian translation).

6508/13046
CSO: 1842/114

UDC 669.715:621.74

MODIFICATION OF ALUMINUM CASTING ALLOYS WITH AN Al-Ti-B MASTER ALLOY

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 60-61

[Article by A.A. Abramov, L.I. Sarafanova and I.M. Shumilova]

[Abstract] The effectiveness of a Ti-B modifying system was studied using A99 aluminum plus the alloys Al9F and Al2M, melted in a high-frequency induction furnace in graphite crucibles. Mechanical properties were determined on specimens cut from ingots 50 mm in diameter cast in a chill mold and heat-treated. Modification of aluminum casting alloys with Ti and B introduced as Al-Ti-B was found to be a very effective means for stable production of good mechanical properties in the alloys. The effectiveness of treatment is explained by the presence in the master alloy of a large quantity of fine globular segregations of Al_3Ti . References 6: 2 Russian, 4 Western.

6508/13046
CSO: 1842/116

UDC 621.745:662.81

BRIQUETTING OF NONFERROUS METAL CHIP BEFORE MELTING

Moscow TSVETNYYE METALLY In Russian No 12, Dec 85 pp 70-71

[Article by G.T. Ptashnik]

[Abstract] In order to increase the effectiveness of the melting of chips at nonferrous metal processing plants, they are formed into sandwiches in PG-100 and S-26 presses yielding a maximum density of 2.5 kg/dm^3 . Remelting of these sandwiches is superior to melting bulk chip but hardly the best solution. The most promising solution is melting of sandwiches with a density of up to 6 kg/dm^3 , which can be achieved on a horizontal type B-654 briquette press with 6300 MN pressing force. The productivity of the press can be significantly increased by 100% utilization of the power of the briquette press and decreasing the length of the chips used. Finished briquettes are produced in the shape of a truncated cone with density up to 6 kg/dm^3 and a mass of 9-10 kg, containing 1-1.5% emulsion and 0.01-0.15% oil. References 1: Russian.

6508/13046
CSO: 1842/112

UDC 621.315.592

MECHANISM OF FORMATION OF MICROINCLUSIONS OF A^{III} COMPONENT IN A^{III}B^V
SEMICONDUCTORS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 12, Dec 85
(manuscript received 26 Mar 84) pp 2003-2005

[Article by Ye.A. Glushkov, N.V. Izmaylov, A.A. Litvin, S.I. Rembeza,
A.M. Tuzovskiy, S.K. Turkov and N.P. Yaroslavtsev, Voronezh Polytechnical
Institute]

[Abstract] The purpose of this work is to determine the maximum concentration of inclusions for a number of A^{III}B^V-type semiconductors and clarify the mechanism of their formation. Internal friction was determined on three types of installations which covered the range of oscillation frequencies from a few Hz to several KHz. In all cases flexural oscillations were activated in specimens made of crystals grown from melts by the Chokhralskiy method. The variation of internal friction as a function of temperature in the semiconductors containing gallium and indium microinclusions was determined. This study indicated that the predominant mechanism of formation of microinclusions of the A^{III} component is a mechanism related to decomposition of a supersaturated solid solution of this component in A^{III}B^V.
References 11: all Russian.

6508/13046
CSO: 1842/120

UDC 669.12:669.786:66.069.84

DENITRATION OF DECARBURIZED IRON DURING VACUUM REFINING BY JET TREATMENT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 10 Jul 85) pp 39-44

[Article by V.I. Dmitriyenko and G.O. Neygebauer, Siberian Metallurgical Institute]

[Abstract] Denitration of refined iron containing already less than 0.008% C but still 0.01-0.047% N₂ was studied, vacuum refining being done by jet flow from the furnace crucible rather than by boiling inside it. Metal molten in an IST-0.06 laboratory induction furnace was poured through a funnel and a perforated aluminum deoxidizer plate, at a temperature within the 1650-1720°C range, after having been predeoxidized with 0.20-0.40% Si. Chemical analysis of 34 ingots weighing 40 kg each has revealed how the drop in nitrogen concentration and the final nitrogen concentration depend on the initial nitrogen concentration. The data also reveal how the nonuniformity of the denitration reaction, namely, the difference between final and equilibrium nitrogen concentrations, depends on the initial nitrogen concentration and on the residual pressure in the vacuum chamber.

On the basis of these results, an equation of denitration kinetics is derived, a first-order differential equation for the rate of change of nitrogen concentration as a function of forward-reaction and reverse-reaction rate constants, volume of metal, and interaction surface area. The interaction surface area is proportional to the difference between instantaneous nitrogen concentration and nitrogen concentration in equilibrium with the partial pressure of nitrogen in a gas bubble. An evaluation of the results indicates that oxygen in any concentration prevents thorough denitration of iron by any of the two methods. References 4: 3 Russian, 1 Western (in Russian translation).

2415/13046
CSO: 1842/133

UDC 669.018.25:620.178.1

STRENGTH OF INSERTS IN SUPPORT PLATES FOR HIGH-PRESSURE TOOLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 5 Apr 85) pp 81-84

[Article by A.F. Sofroshenkov, N.M. Panina and O.V. Gordin, deceased,
Siberian Metallurgical Institute]

[Abstract] A feasibility study was made concerning replacement of the scarce hard alloys VK6 and VK15 with any of the high-speed cutting steels R6M5, R12F4K5, R18F2K8M, R9M4K8, R12F3K10M3, R8M3K6S, die steels Kh12M, 2Kh2V8F, 5Kh3V3MFS, or austenitic 60G10KhNL steel for die support plates. forgings of these steels, except for the 60G10KhNL, were subjected to a preliminary heat treatment producing a sorbitic pearlite structure and then to a final heat treatment appropriate for each grade of steel — decarburization, minimum unalloying, and complete breakup of carbide grain clusters. Inserts for die support plates were produced from blank forgings after this heat treatment and, after being heat treated again to the proper hardness, tested mechanically under conditions simulating those applicable to plate inserts made of hard alloys VK6 or VK15. The results reveal a dependence of the fracture mode on the hardness, fracture being caused principally by overstresses within the contact zones and by a highly nonuniform distribution of stresses over the insert volume. Under compression loads, particularly, plastic macrodeformation was found to proceed on a local scale around large, irregular carbide grain clusters. A comparative evaluation of all the steels involved here indicates that R12F4K5, R8M3K6S, and R12F3K10M3 are best qualified to replace the VK15 alloy for inserts in die support plates.
References 2: both Russian.

2415/13046
CSO: 1842/133

DEPENDENCE OF FORMABILITY OF KhN65VMTYu HEAT-RESISTANT ALLOY ON SULFUR-MAGNESIUM-CALCIUM BALANCE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 85 (manuscript received 31 Jan 84) pp 87-90

[Article by D.A. Soskov, F.I. Shved, S.N. Chuvatina and L.V. Sergeyeva,
Chelyabinsk Scientific Research Institute of Metallurgy]

[Abstract] A study of the KhN65VMTYu heat-resistant nickel alloy (16% Cr, 9% W, 4% Mo, 1.5% Ti, 1.5% Al) was made, for the purpose of determining the dependence of its formability on the balance between sulfur, alkali-earth metals, and rare-earth metals present in microamounts. Ingots of this alloy weighing 30 kg were produced in a vacuum-induction furnace, from a mixture of pure metals and from industrial tailings. The latter were melted under a residual pressure of 5-8 Pa, whereupon in argon under atmospheric pressure, Ce, B, Mg were added first and then, before casting, also Mg and Ca. The sulfur content was varied artificially over the 0.002-0.018% S range, by addition of FeS in proper amounts, while the magnesium content was varied over the 0.001-0.047% Mg range and the calcium content was varied over the 0.004-0.019% Ca range, with the cerium content varying over the 0.001-0.009% Ce range. Nonmetallic inclusions and excess phases were determined qualitatively under an MIM-8M microscope and a Neofot-2 microscope, during examination of grain boundaries, as well as quantitatively in an MS-46 x-ray spectral microanalyzer. As the sulfur content increased from 0.002% S through 0.005-0.008% S to 0.011% S, the optimum magnesium content for maximum resilience during hot rolling increased from 0.007% Mg through 0.011-0.019% Mg to 0.010-0.024% Mg with the allowable calcium content increasing correspondingly from 0.003% Ca through 0.006-0.007% Ca to 0.008% Ca. The amounts of carbides, carbonitrides, and nitrides was found not to depend on the Mg and Ca microcontent. Sulfides were found to form only as the sulfur content had reached the 0.007-0.008% S range with only up to 0.004% Mg present, but to become abundant and not dependent on the magnesium content as the sulfur content had exceeded 0.008% S. Sulfides included TiS_2 as well as MgS and CaS, magnesium and calcium also forming an intermetallic compound. An analysis of the data indicates that maximum plasticity of the alloy corresponds to zero excess sulfur content, this excess sulfur content being definable as $\Delta S = |S| - 0.8 |Ca| - 0.3 |Mg| - 0.35 |Ce|$, while a resilience higher than $200 J/cm^2$ is attainable only with an excess sulfur content ranging from -0.003% to +0.003%. References 6:
4 Russian, 2 Western.

2415/13046
CSO: 1842/133

PROCESSES OCCURRING DURING REDUCTION AND ALLOY FORMATION IN $\text{MoO}_3\text{-WO}_3\text{-H}_2$ SYSTEM, PART 2: LOW-TEMPERATURE ALLOY FORMATION IN Mo-W SYSTEM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received 24 Dec 84) pp 1-5

[Article by M.P. Savyak, I.V. Uvarova, L.D. Konchakovskaya and V.V. Skorokhod, Institute of Materials Science Problems, UkrSSR Academy of Sciences]

[Abstract] Formation of Mo-W alloys from mixtures of MoO_3 and WO_3 oxides at low temperatures ($370\text{-}900^\circ\text{C}$) is analyzed, particularly the dependence of alloy homogenization on the concentrations of component metals in the powder mixture and on the temperature at which their oxides are reduced. Alloys with equal atomic percentages of molybdenum and tungsten have been produced from a mechanical mixture of oxides $\text{Mo}_{0.5}\text{W}_{0.5}\text{O}_3$ by vacuum annealing and from a chemical mixture of oxides by cyclic reduction-oxidation. Reduction at stepwise raised temperature from 370°C to 900°C did not produce a solid solution from the mechanical mixture, but at 900°C began to produce a solid solution from the chemical mixture. Simultaneous reduction of both oxides was found to lower the temperature of alloy formation in a system with complete solubility of the components, homogenization of the alloy being facilitated by better mixing of the oxides and by raising the reduction temperature. The characteristics of alloy formation at low temperatures of $370\text{-}900^\circ\text{C}$ were found to follow the same general trend as those of alloy formation at high temperatures of $1600\text{-}2300^\circ\text{C}$. Changing the ratio of component metals away from the 50:50 atom.% was found to result in incomplete dissolution and thus incomplete homogenization, as indicated by widening of the (321) line and shifting of its peak toward tungsten in the case of low tungsten concentration (25 atom.% W, 75 atom.% Mo) or toward molybdenum in the case of high tungsten concentration (75 atom.% W, 25 atom.% Mo). The rate of mutual dissolution of the metals depends on the degree of homogeneity of the powder mixture of their oxides. The data obtained here agree with earlier data on interdiffusion in this system. References 19: 17 Russian, 2 Western.

2415/13046
CSO: 1842/134

PRODUCTION OF METAL POWDER BY CENTRIFUGAL ATOMIZATION OF MELT

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 85 (manuscript received 10 Jan 85) pp 5-10

[Article by A.V. Kharitonov and Sh.M. Sheykaliyev, Department 2, Moscow Engineering Physics Institute]

[Abstract] A centrifugal atomizer has been developed for production of metal powders by centrifugal action on the melt with liquid metal fed into the rotating device, rather than by the conventional but less expedient method of spinning a solid bar while melting it in an electric arc. The experimental prototype of this device includes a 3 m high hermetic melting chamber and a powder collector. The melting chamber has three compartments, metal being melted in a crucible with both a graphite resistance heater and a water cooling coil around. Electric power to the heater is supplied through a 40 kW transformer with smooth voltage regulation by means of thyristors. This crucible is made of graphite or steel and can hold 3-5 kg of metal, inside a hermetic sheath made of Cr18Ni9Ti heat-resistant steel, designed for operation at temperatures of 500-1300 K under pressures up to 3 MPa. Built into the bottom of this crucible is a sprayer, also made of graphite or steel, which consists of a threaded helical turbulizer and a converging nozzle with a cylindrical spout. Argon or helium is used as stirring agent, the necessary equipment including an NVZ-20 forevacuum pump and an AVP-250/630 vapor-oil feeder set. Powders of magnesium, tin, BrO20 bronze, aluminum, and an aluminum alloy were produced with this device, melt superheat temperature and melt pressure as well as spout diameter having been optimized for yielding the finest possible powder with most efficient consumption of liquid metal. Using as little as $(5.2-7.5) \cdot 10^{-3}$ nm/kg of liquid metal, powder metal could be produced by a single atomizer nozzle at a rate as high as 40 kg/h with argon as stirring gas. The powder dispersion improved depending on the melt pressure and on the spout diameter, its grain size decreasing most appreciably as the melt pressure was raised to 0.6-0.8 MPa but not much more under still higher melt pressures and the finest grain being produced with a spout 0.3 mm in diameter. Spouts with diameters either larger or smaller than 0.3 mm produced coarser powders.

References 10: all Russian.

2415/13046
CSO: 1842/134

UDC 621.762.5

EFFECT OF MANGANESE ON SINTERING PROCESSES IN Ti-Fe SYSTEM, PART 1:
VOLUMETRIC CHANGES DURING SINTERING OF Ti-Fe-Mn COMPACTS

Kiev POROSHKOVA METALLURGIYA in Russian No 12, Dec 85 (manuscript
received 28 Dec 84) pp 40-44

[Article by L.I. Kivalo and V.V. Skorokhod, Institute of Materials Science
Problems, UkrSSR Academy of Sciences]

[Abstract] The effect of adding manganese to Ti-Fe powder mixture on the sintering processes in this system was studied over the 900-1250°C temperature range covering the triple eutectic point at 1050°C. Used for the experiment were titanium powder which had been produced by reduction of titanium oxide through hydriding and with calcium (specific surface area $6.7 \text{ m}^2/\text{g}$) and iron powder PZh4M2 (specific surface area $0.1 \text{ m}^2/\text{g}$) or V3 (specific surface area $2.5 \text{ m}^2/\text{g}$) as well as ferromanganese powder (specific surface area $0.67 \text{ m}^2/\text{g}$). The volumetric changes in Ti-Fe and Ti-Fe-Mn systems were measured as the temperature in the SShVL vacuum furnace ($12 \cdot 10^{-4} \text{ Pa}$) was raised in 50°C steps and held at each level for 2 h. The intensity profiles of the (321) line were recorded in a DRON-0.5 x-ray diffractometer using CuK α and FeK α sources, for phase analysis. The data indicate that sintering in the Ti-Fe system is accompanied by shrinkage at temperatures below the eutectic point and by dilation above it, the magnitude of these volume changes depending not only on the sintering temperature but also on the dispersion of the powders in the mixture. Addition of manganese has been found to intensify interdiffusion of the component metals and thus also the alloy formation process, with intermetallic compounds $\text{Ti}(\text{Fe},\text{Mn})$, $\text{Ti}(\text{Fe},\text{Mn})_2$, $\text{Ti}_4(\text{Fe},\text{Mn})_2\text{O}$ appearing already at 900-1000°C. References 7: 2 Russian, 5 Western.

2415/13046
CSO: 1842/134

UDC 621

SINTERING OF PRODUCTS OBTAINED BY COMBUSTION OF ALLOYS IN NITROGEN

Kiev POROSHKOVA METALLURGIYA in Russian No 12, Dec 85 (manuscript
received 28 Jul 83) pp 44-49

[Article Yu.M. Maksimov, L.G. Raskolenko, M.Kh. Ziatdinov and O.K. Lepakova,
Scientific Research Institute of Applied Mathematics and Mechanics, Tomsk
University]

[Abstract] Compaction of composite material consisting of α -Fe and δ -VN by a fusion wave following combustion was studied, this composite material being produced by combustion of a Fe-V alloy with an σ -phase structure. Used for

the experiment were alloys containing 50 wt.% Fe, made by vacuum-sintering of VEL-1 vanadium powder and extra-pure carbonyl iron powder. Such alloys were comminuted to a powder of less than 50 μm dispersity with a specific surface area of $0.21 \text{ m}^2/\text{g}$, this powder then being pressed into cylindrical specimens 20 mm in diameter with a porosity of 40-50%. These specimens were burned in nitrogen and subsequently quenched in water, for metallographic examination under an MIM-7 microscope, phase analysis in a DRON-2 x-ray diffractometer, and hardness measurement with a PMT-3 tester. The combustion temperature was recorded by W/Rh thermocouples and the combustion process was monitored on moving photographic film. The combustion products were found to be a sintered material with less than 5% porosity. The temperature-time profile of the fusion wave was found to encompass three zones: I) heating of the alloy powder from room temperature to the melting point of iron (1820 K) with attendant nitriding of σ -FeV and σ - α phase transition at 1470 K, all within a time of 0.12 s; II) dispersion of vanadium nitrides by molten iron with attendant coalescence of nitrided ferrovanadium droplets into a single solidifying liquid pool, all within the next approximately 2 s of time; III) slow cooling of the melt down to room temperature. A quantitative analysis of processes and materials in zone II based on the Navier-Stokes equation for this zone, assuming spherical droplets of identical size, and on the model of diffusion-controlled creep yields the coalescence time and the viscosity of nitrided ferrovanadium as well as the volume fraction of nitrides formed in the process. All are found to depend on the grain size of the original alloy powder. References 19: 13 Russian, 6 Western (2 in Russian translation).

2415/13046
CSO: 1842/134

TREATMENTS

UDC 621.771-416

MECHANISM OF DEFORMATION AND HARDENING OF BERYLLIUM BY COLD ROLLING

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 13 Aug 84) pp 68-71

[Article by A.K. Grigoryev, N.G. Kolbasnikov, N.B. Artemyev and A.S. Andrushchenko, Leningrad Polytechnical Institute, Department of Plastic Working of Metals]

[Abstract] Beryllium was rolled on DUO-80 and quarto 15-55 mills with reductions of 0.2-1.0% per pass. Intermediate heat treatment was performed in a vacuum of $1 \cdot 10^{-2}$ Pa at 1100 K. The microhardness and density of the resulting foils were determined. It was found that the mechanism of deformation of beryllium by cold rolling is determined by the interaction of dislocations with impurity inclusions. The inclusions may be broken down by rolling, resulting in the formation of microcracks. The stress necessary to break down particles of beryllium oxide, the major impurity in beryllium, is estimated. Shear stresses of 425 MPa are sufficient to break up the particles and form microcracks. The tensile stress in the metal must be monitored during cold rolling of beryllium to prevent development of these microcracks upon crushing of inclusions. References 9: 6 Russian, 3 Western.

6508/13046
CSO: 1842/121

UDC 539.62:663.665.2

PHYSICAL AND CHEMICAL PROCESSES IN FRICTION OF PHENOL-FORMALDEHYDE POLYMER WITH HARD ALLOY

Minsk TRENIYE I IZNOS in Russian Vol 6, No 6, Nov-Dec 85 (manuscript received 10 Dec 84) pp 1012-1018

[Article by A.L. Zaytsev and P.V. Sysoyev, Institute of the Mechanics of Metal Polymer Systems, Belorussian Academy SSR of Sciences, Gomel]

[Abstract] An attempt is made to study the physical and chemical processes occurring upon friction between a phenol-formaldehyde polymer and a hard

alloy, and to estimate their influence on the kinetic characteristics of the friction. The objects of the study were a resol phenol-formaldehyde resin type LBS-3 and series-produced hard alloy type VK6-M, the surface of which was treated to a roughness of 0.08-0.1 micrometers. Analysis of the friction properties showed the significant influence of the oxidation activity of the gas environment on friction and wear characteristics. In the initial period of friction, there is a sharp increase in the force of friction and in heat liberation in the contact zone associated with wearing in of the surfaces, causing competing processes of structuring and mechanical destruction in the surface layers of the polymer. Mechanical cracking of the surface layer of the resin, increasing the number of paramagnetic centers and leading to formation of free radicals, as well as partial oxidation of the surface of the tungsten-cobalt alloy upon friction in air, help to form individual transfer fragments on it. As the contacting materials fit together better, with further oxidation of the hard alloy and carbonization of the phenol resin, more complete tribochemical interaction occurs with the formation of transfer layers as solid films, a mixture of amorphous carbon and possibly condensed aromatic structures with tungsten and cobalt oxides, changing the mechanism of friction interaction and leading to a decrease in the coefficient of friction and rate of wear. Friction in an inert atmosphere results in less wear of the materials. References 7: 6 Russian, 1 Western (in Russian translation).

6508/13046
CSO: 1842/122

UDC 621.891

WEAR OF INTERNAL CYLINDRICAL SURFACE BY IMPACTS OF FREE PARTICLES

Minsk TRENIYE I IZNOS in Russian Vol 6, No 6, Nov-Dec 85 (manuscript received 10 Nov 84) pp 1019-1025

[Article by V.N. Kashcheyev and A.N. Solod, Siberian Physical Technical Institute imeni V.D. Kuznetsov, Tomsk]

[Abstract] A study is made of the mechanics of collisions during rotation of the centrifugal accelerator and specimen being bombarded as applicable to impacts of very hard steel balls. Hardened and polished balls of type ShKh15 bearing steel and specimens of hardened type ShKh15 steel bearing races with smoothed surfaces were used. At a certain relationship of tangential speeds of the inner vertical surface and the ball impacting the surface in the horizontal plane, it is possible for the ball to stick to the vertical surface and rotate together with it. The balls may coat the vertical surface as a compact layer, protecting it from further wear. The retention of balls on vertical and even conical surfaces with downward opening cannot be explained by the action of centrifugal force alone. It is facilitated by roughness depressions on the interacting surfaces, resulting from previous ricochet impacts of the balls. References 13: 6 Russian, 7 Western (2 in Russian translation).

6508/13046
CSO: 1842/122

UDC 621.923.079:621.892

CONTACT COPPER PLATING ELECTROLYTE AS BOUNDARY LUBRICANT IN DIAMOND
BURNISHING OF STEELS

Minsk TRENIYE I IZNOS in Russian Vol 6, No 6, Nov-Dec 85 (manuscript
received 21 Feb 84) pp 1040-1047

[Article by Yu.N. Dorofeyev and Ye.M. Golubchik, Bryansk Institute of
Transport Machine Building]

[Abstract] A study was made of the possibility of increasing the durability of diamond tools and the quality of surfaces worked during burnishing of steel with the aid of a layer of glycerin electrolyte containing copper chloride and carboxylic acid. These substances decrease surface energy and facilitate plastic deformation of the metal, helping to remove the oxide film, and facilitating desorption of organic compounds. The use of the glycerin electrolyte for contact copper plating of steel as the boundary lubricant in diamond burnishing is found to be an effective means of increasing tool durability and improving surface quality. References 13: all Russian.

6508/13046
CSO: 1842/122

UDC 621.375.826

ABSORPTION OF NEODYMIUM LASER RADIATION IN PLASMA FLAME DURING DRILLING OF
DEEP APERTURES

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 10 Jan 84) pp 17-22

[Article by A.A. Bakeyev, L.I. Nikolashina, N.V. Prokopenko and
V.I. Yakovlev, Moscow]

[Abstract] Complex measurements of plasma flame parameters are performed for a flame, the radial scattering of which is limited by the walls of a quartz tube. The results obtained are used to interpret the physical mechanisms which cause pulsation during laser drilling. The effects of laser radiation were studied on specimens of aluminum, titanium, and bismuth. A pulsating plasma flow mode was observed, similar to that observed in laser drilling of deep apertures. The stage of the process involving interaction of radiation with the matter when the height of the plasma flame is not greater than the length of the tube is analyzed. The results indicate that pulsating laser drilling of deep apertures results from development of absorption waves in the air which form almost immediately after absorption bursts in material vapors. Radial scattering limitation by the quartz tube makes the process almost one-dimensional, though there are a number of factors which distinguish the experiments from the one-dimensional model, including radial radiation losses, heat exchange with tube walls, contamination

of the plasma with matter evaporated from the tube walls, the influence of the boundary layer on plasma flow speed and flow of the plasma into the gap between the specimen and the tube. References 15: all Russian.

6508/13046
CSO: 1842/114

UDC 621.785:535.211:669.15-194:669.017

BEHAVIOR OF SULFIDE INCLUSIONS UPON LASER HEAT HARDENING OF STEEL

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 6, Nov-Dec 85
(manuscript received 12 Jul 84) pp 23-27

[Article by S.I. Gubenko and N.V. Varavka, Dnepropetrovsk]

[Abstract] The purpose of this work was to study the behavior of sulfide inclusions of various types, including eutectics FeS-(Fe,Mn)S and (Fe,Mn)S-FeO in type NB-57 steel, FeS, MnS (Fe,Mn)S, eutectics FeS-MnS, MnS-(Fe,Mn)S, FeS-FeO, FeS-(Fe,Mn)S, (Fe,Mn)S-FeO in type 08KP, 08Yu, ShKh15, and 08Kh steels, eutectics FeS-(Fe,Mn,Cr)S, FeO-(Fe,Cr)S in 08Kh and ShKh15 steels. Sulfide inclusions were identified metallographically, by micro x-ray spectral and petrographic methods. Changes were found to occur in sulfide inclusions and the steel matrix near the inclusions in the process of laser hardening. Sulfide inclusions melt when struck by the laser beam, while the matrix around them may not melt. Diffusion exchange of atoms of the matrix and inclusions occurs, resulting in saturation of the steel matrix with sulfide components under the influence of the difference in chemical potentials of the elements. The microhardness of the steel matrix near sulfide inclusions increases. The sulfide inclusions flow out over the surface, then crystallize rapidly. Sulfide inclusions thus facilitate nonuniform hardening of the steel by the laser beam and cause the appearance of surface defects. References 5: all Russian.

6508/13406
CSO: 1842/114

UDC 669.721.5:621.74.043

PROPERTIES AND STRUCTURE OF CAST β -ALLOYS IN THE Mg-Li-Al SYSTEM

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 56-59

[Article by L.V. Nikulin, S.B. Shevrikoko and Ye.V. Belozerova]

[Abstract] The mechanical properties of a group of Mg-Li-Al alloys cast in a chill mold, crystallized under piston pressure of 200 MPa and cast in a machine for pressure casting with a cold horizontal pressure chamber were studied. The content of aluminum in the alloys varied from 1 to 10%, the

composition of the binary Mg-Li base being maintained constant at Mg - 14% Li. Alloys were prepared in a resistance furnace under a flux of 75% LiCl + 25% LiF. Analysis of the density, specific strength, and ductility of the system showed that a promising combination of tensile strength and relative elongation is obtained in alloys with 3 to 7% Al by mass. These alloys can serve as the basis of a group of industrial casting alloys providing a strength of over 200 MPa with a specific strength of at least 15-16.
References 5: all Russian.

6508/13046
CSO: 1842/112

UDC 621.746.27.047

INFLUENCE OF DRAWING RATE ON QUALITY OF CONTINUOUS CAST BILLETS

Moscow STAL in Russian No 12, Dec 85 pp 26-29

[Article by A.L. Liberman, V.I. Lebedev, Yu.Ye. Kan, P. Yevteyev and Ye.P. Matevosyan, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] Studies of the influence of the teeming rate on metal quality were performed on a vertical continuous caster using steel type 3sp, 10sp, and 09G2 melted in 160-ton converters. The steel was poured into crystallizers 240 x 1850 mm, 240 x 1500 mm, and 240 x 1710 mm in cross-section. The metal surface was protected using a heat-insulating slag-forming mixture based on cement. Metal quality was studied using transverse and longitudinal templates plus surface specimens. The templates were etched in 50% hydrochloric acid. The depth of folds and quantity of nonmetallic inclusions were determined on microsections by a metallographic method and zonal chemical heterogeneity by spectral analysis. Slow drawing (0.1-0.2 m/min) produces good quality billets with axial chemical heterogeneity grading not over 2. Slower drawing results in increased dispersion of the dendrite structure and decreased axial liquation with good surface quality.
References 3: 2 Russian, 1 Western (in Russian translation).

6508/13046
CSO: 1842/124

ROLLING TECHNOLOGY ON SIX-STAND 1400 MILL

Moscow STAL in Russian No 12, Dec 85 pp 36-39

[Article by F.I. Zenchenko, O.N. Soskovets, V.I. Baranov, A.V. Nogovitsyn, P.P. Chernov, Ye.A. Bender, V.L. Mazur, V.N. Skorokhodov and B.Ya. Mikityanskiy, USSR Ministry of Ferrous Metallurgy; Karaganda Metallurgical Combine; Central Scientific Research Institute of Ferrous Metallurgy; Institute of Ferrous Metallurgy; and Scientific-Research and Design-Technological Institute of Heavy Machine Building Uralmash Production Association]

[Abstract] The six-stand 1400 mill at the Karaganda Metallurgical Combine is used for cold rolling of thin strips and sheet 0.16-0.60 mm thick and 700-1250 mm wide. The mill includes two decoilers, a joint welder, and a looping unit with a capacity of 400 m. At first, the mill was operated with most of the reduction in the first five stands, the sixth stand acting as a dressing stand. Attempts to increase the reduction achieved in the sixth stand had unfavorable results. It was found that the anomalous results occurred only when rolling to a final thickness of less than 0.25 mm. Under these conditions, attempts to increase reduction in the final stand too greatly had a major influence on rolling force and resulted in stretching of the output product. The optimal reduction in the final stand was found to be 30-45%. References 5: all Russian.

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CSO: 1842/124

PRODUCTION OF STEEL-NONFERROUS METAL PIPE

Moscow STAL In Russian No 12, Dec 85 pp 45-47

[Article by Ye.A. Resnikov, Yu.Z. Komarovskiy, Yu.G. Buryak and L.S. Lyakhovetskiy, All-Union Scientific-Research and Design-Technological Institute of the Pipe Industry; Dnepropetrovsk Pipe Rolling Plant imeni Lenin; Ukrainian State Institute for the Planning of Metallurgical Plants]

[Abstract] Industrial production of bimetallic pipe with outer layers of steel and inner layers of copper, as well as pipe for friction bearings with outer layers of steel and inner layers of bronze, involves cold joining of layered blanks and subsequent thermal diffusion welding with cold rolling to the necessary dimensions. Heat-treated steel pipe is joined to riveted copper and bronze pipe to create an initial tension with contact pressure due to the greater elastic recoil of the copper and bronze pipe, assuring tight contact between the surfaces with no air between layers. Thermal diffusion treatment is performed in continuous roller furnaces heated to 970°C, holding time up to 30 minutes, for copper and 920°C, holding time

up to 30 minutes, for bronze. The dimensions of pipes currently in production are presented in a table. References 1: Russian.

6508/13046
CSO: 1842/124

UDC 621.774.35:621.774.72

IMPROVEMENT OF TECHNOLOGY OF ROLLING HIGH PRECISION BEARING PIPE

Moscow STAL in Russian No 12, Dec 85 pp 47-49

[Article by A.V. Gamershteyn, M.V. Popov, V.D. Mikheyenko, V.N. Volkov and V.N. Ivchenko, Pipe Rolling Plant imeni K. Libknekht; All-Union Scientific-Research and Design-Technological Institute of the Pipe Industry]

[Abstract] A new method has been developed for calculating the width of a roll pass by computer to improve the geometric accuracy of pipe in terms of both diameter and wall thickness. According to the new method, with fixed linear displacement of the metal, the maximum expansion values are determined by the pipe deformation conditions in the area of reduction and at the end of the precalibrated sector which depend correspondingly on the reduction angle and conicity of the mandrel. The results of the investigations are used to select the optimal shape of the reducing portion of the pass and mandrel considering the influence of pipe production factors and tool manufacture. This yields new, more precise equations for determination of the most important parameters of tools and design of passes by computer. The use of a reducing type distributor-feeder mechanism and the new method of cold rolling with adjustable feed increases the straightness of the leading ends of pipes by a factor of 3.3 to 4.0. Reserves found on the basis of the computations allow improvements to be made in the geometric accuracy of bearing pipe in terms of diameter and wall thickness by 20%, and surface regularity by 33%. The improved technology for rolling of high precision bearing pipe allows them to be awarded the state sign of quality while saving some 400,000 rubles per year. References 4: all Russian.

6508/13046
CSO: 1842/124

UDC 621.778.113:669.14.018.24

PRODUCTION OF CALIBRATED TURNED TYPE ShKh15 STEEL 10-15 MM IN DIAMETER IN 0.4 TON COILS

Moscow STAL in Russian No 12, Dec 85 pp 51-52

[Article by S.P. Panasenko, V.I. Shumeyko, D.N. Zhebrakov, L.I. Prokhorova and B.A. Tulupov, All-Union Scientific Research Institute of Metal Products; Orlov Steel Rolling Plant]

[Abstract] As a part of the continuing expansion of the production of calibrated bearing steel in coils, work has been conducted on a technology for producing calibrated turned ShKh15 steel 10-15 mm in diameter in 0.4 ton coils from 12-17 mm diameter coil annealed stock. The stock is etched in hydrochloric acid in two procedures for 2-2.5 hours at not over 40°C, turned and calibrated at 15-25 m/min, removing 1.0-0.6 mm of diameter in the turning process, depending on the depth of surface defects. Recrystallization annealing is performed in a 10-zone continuous furnace in a nitrogen-hydrogen protective atmosphere at 250 Pa. The temperature in the furnace starts at $750-20^{\circ}\text{C}$, then decreases to 650-680°C through the length of the furnace. Production of this product is to double in 1985. References 3: all Russian.

6508/13046
CSO: 1842/124

UDC 669.14.018.58-422

TECHNOLOGY OF PRODUCTION OF HIGH COERCIVITY COLD DRAWN 26Kh15KMYu ALLOY

Moscow STAL in Russian No 12, Dec 85 pp 52-55

[Article by V.V. Pasechnaya, A.Ya. Eydinov and T.A. Khokhlova, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The authors' institute has suggested a technology for producing a new high coercivity alloy containing 26% Cr, 15% Co, 2% Mo, 0.5% Al, remainder iron as cold-rolled rods up to 2 mm in diameter. This article discusses some of the technological specifics of the conversion of ingots to rods of the required diameter, and does not discuss production of the required magnetic properties. The purity of metal produced by open melting is found to be sufficient to produce wire by cold drawing of 8 mm diameter rods. The small numbers of breaks which did occur resulted primarily from surface defects. The ductility of the metal produced by open induction melting, vacuum induction melting, and vacuum induction melting plus electron beam remelting was studied, revealing low ductility and high strength up to 500°C, above which ductility is much higher, strength much lower. The alloy has low ductility in the hot rolled state. Hardening from 1250°C yields a high level of mechanical properties, but makes drawing to wire quite difficult. Hardening from below 1000°C results in the appearance of a σ phase which increases brittleness and greatly reduced ductility. References 6: 4 Russian, 2 Western.

6508/13046
CSO: 1842/124

WELDING, BRAZING AND SOLDERING

MULTIPURPOSE LASER CREATED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Jan 86 p 2

[TASS article, Leningrad: "Multipurpose Laser"]

[Text] A steel sheet is not a piece of paper, yet it has just been cut by a light beam like paper is cut by scissors. And the indefatigable laser is already performing the next task--it is applying fused-powder coatings. Then it turns to welding and heat treatment. This is how the completed trials demonstrated the truly universal "abilities" of the unit created (sozdannaya) at the All-Union Electric Welding Equipment Institute. The unit, which replaces a whole set of specialized equipment, has been recommended for series production.

In order to make the laser multipurpose, the Leningrad scientists have perfected a system for controlling the light flux range. The power of the laser, and thus its power content, is small--only 2 kW--but, on the other hand, the scientists have succeeded in achieving an enormous energy concentration; it is 1,000 times higher than in an electric arc.

The equipment can be quickly adjusted: A lens change is sufficient to convert it to a different function. Such a unit is being successfully included in the flexible automatic production systems capable of promptly being converted to the production of new products, which are being created today.

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DIAGRAM OF PULSE-PERIODIC LASER WELDING MODES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 1-3

[Article by G.I. Levin, engineer]

[Abstract] Pulse-periodic laser welding has a number of specific parameters such as the duty factor which can be quite informative. This article presents equations to determine the area where welding by melting occurs, due to sufficient depth of melting and tolerable losses to vapor formation, as well as continuous presence of melt at the rear wall of the crater, necessary to assure sufficient chemical homogeneity during welding of alloys. The equations define curves on the plane of power versus duty factor which enclose an area of the parameters within which it is possible to produce welded joints by melting in the pulse-periodic mode.
References 13: 8 Russian, 5 Western.

6508/13046
CSO: 1842/108

UDC 621.791.16.03

OPTIMIZATION OF FRICTION WELDING OF METALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 p 6

[Article by A.S. Seregin, engineer]

[Abstract] Results are presented from studies of the process of welding by friction using a method of partial braking after the electric motor rotating a spindle is switched off, practically instantly shifting from high speed to low speed, with subsequent reduction of the rotating frequency of the spindle by the forces of friction in the joint. Three series of experiments were conducted: without artificial braking, with full counter current braking, and with partial braking, almost instantly dropping the speed from 2000 to 1100 rpm. Type R6M5 steel + type 45 steel and type 20 steel + type 20 steel were welded. Partial braking with subsequent free run-down of the rotating masses is found to improve welding conditions, preserving all the

advantages of welding without artificial braking, but eliminating the initial "polishing" stage in which the coefficient of friction in the welded joint is reduced. References 5: all Russian.

6508/13046
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UDC 621.791.678.029.43

SPECIFICS OF WELDING OF THREE-DIMENSIONAL STRUCTURES FROM FLAT POLYMER BLANKS AND REQUIREMENTS FOR WELDING EQUIPMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 8-10

[Article by A.V. Bogdashevskiy, candidate of technical sciences, V.A. Maklyarovskaya, engineer, L.N. Matsyuk, candidate of technical sciences, and N.M. Abyzov, candidate of technical sciences]

[Abstract] A study is made of the conditions for welding of structures with lap joints of film materials, some of the requirements for welding equipment, ways of increasing labor productivity, and specifics of the cutting of blanks. The radius of the electrode surface during welding of a curved seam must be equal to the radius of the structure. Otherwise, seam formation will be incorrect and wavy. The length of the welding electrode is computed based on the requirements of maintaining optimal pressure over the length of the electrode and the physical-mechanical and rheologic properties of the material being welded.

6508/13046
CSO: 1842/108

UDC 621.791.052.08:620.179.16

COMPARATIVE ANALYSIS OF EFFECTIVENESS OF ULTRASONIC TESTING OF WELDED JOINTS IN AUSTENITIC STEELS FOR POWER EQUIPMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 10-12

[Article by V.M. Lantukh, engineer, All-Union Heat Engineering Institute imeni F.E. Dzerzhinskiy]

[Abstract] There are two main methods of increasing the noise tolerance of testing of welded joints in austenitic steels: selection of optimal testing parameters and the use of statistical methods of detection of useful echo signals against the background of structural noise. Specimens of joints with base metal thicknesses of 10 to 25 mm were constructed of several types of austenitic steel. Metallographic studies of the grain structure in the weld and the heat-affected area were performed, as well as ultrasonic testing using several types of detectors. Optimal noise tolerance was achieved at

1.8 MHz, prism angle 50°, and piezoelement diameter 18 mm. The acoustical parameters of the special converter allow detection of potentially dangerous defects in butt joints of power equipment. The ultrasonic testing methods can be recommended as a supplement to the radiographic method and as the main method for detection of defects in the depth of the metal where radiographic testing is impossible. References 9: all Russian.

6508/13046
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UDC 621.791.14.03

INCREASE IN JOINT STRENGTH IN WEDGE PRESSURE WELDING OF ALUMINUM WITH STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 12-14

[Article by V.A. Kolesnichenko, candidate of technical sciences, Metallurgy Institute imeni A.A. Baykov]

[Abstract] This article presents a method for calculation and experimental check of the kinetics of the increase of strength in the joints of the metals upon wedge-pressure welding of aluminum alloy AMg₂ and corrosion resistant steel type 12KH18N9T. The materials were heated and pressed in a vacuum of $1.3 \cdot 10^{-2}$ Pa. Welded joint strength was determined by impact bending testing of specimens cut perpendicular to the contact surface at points at 10, 50, and 90% of the height of the load-bearing portion of the steel part. Relative joint strength is found to depend on the rate of plastic deformation of the aluminum and contact shear stress. An equation is suggested for analysis of the kinetics of the growth in strength of joints upon wedge-pressure welding of metals differing greatly in hardness, based on general concepts of the process of the formation of a solid phase joint. It is shown that, in wedge-pressure welding, firm contact between metals is formed as a result of the four main technological parameters of the process: temperature, contact shear stress, contact time, and the angle of working of the pressed part. References 6: 5 Russian, 1 Western.

6508/13046
CSO: 1842/108

UDC 621.791.621.692.1

COLD TOLERANCE OF METAL IN HEAT-AFFECTED ZONES OF WELDED JOINTS IN VESSEL STRUCTURES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 15-17

[Article by N.V. Ivanova, V.N. Dikun, candidates of technical sciences, All-Union Scientific Research Institute of Installation and Special Construction Work; and V.A. Vinokurov, doctor of technical sciences, Moscow Higher Technical School imeni N.E. Bauman]

[Abstract] An estimate is presented of the resistance to failure of metals in the heat-affected zone of welded joints in the metal of manufactured vessels. The joints are made by automatic 2-arc welding under flux without finishing of the edges in a single pass. The mechanical properties of the welded joints of the low-alloy steels are heterogeneous so that their usability depends on the failure resistance of the metal in the most brittle portion of the heat-affected zone. It is found that at temperatures of 20 to -70°C, the most brittle portion of the heat-affected zone is an area of incomplete recrystallization 5 mm from the melt line. An evaluation is presented of several technological versions of automatic welding under flux of vessel wall panels. In addition to the technology described above, for type 16G2AF steel, automatic welding under flux with a specific heat input of 3700 kJ/m in one pass on each side is suitable for use at temperatures no lower than -40°C. For use at temperatures down to -65°C, butt joints should be made with V-shaped finishing of the edges in three passes with a heat input of 2700 kJ/m for each pass. References 7: 6 Russian, 1 Western.

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CSO: 1842/108

UDC 621.791.052:620.17

INFLUENCE OF HYDROGEN ON LONG-TERM STRENGTH OF WELDED JOINTS FROM TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 17-18

[Article by A.I. Gorshkov, candidate of technical sciences, L.N. Pongilskaya, F.R. Kulikov and Yu.V. Vaskin, engineers]

[Abstract] The influence of hydrogen on long-term strength and tendency toward delayed fracture, strength loss, and increased brittleness of welded joints of titanium alloys has been studied in the past. In this article, the heat-affected zone, weld metal, and base metal were tested. Various levels of hydrogen content were created by hydrogenation of the welded materials. The hydrogen content in the welded metal fluctuated widely. Alloy type OT4-1 showed the greatest tendency toward hydrogen saturation.

Long-term strength testing showed that the tensile strength of joints of this metal containing 0.02% hydrogen is 7 MPa. Increasing hydrogen content to 0.04% decreases strength to 5.5 MPa, while at 0.1% hydrogen it is 2.2 MPa. Alloys VT1-0 and VT129 have the least sensitivity to hydrogen and PT7M and OT4-1 the most. References 4: all Russian.

6508/13046
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UDC 621.791.052:620.17

INFLUENCE OF HYDROGEN ON PROPERTIES OF AREA ADJACENT TO WELD IN 16G2AF HIGH-STRENGTH STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 18-20

[Article by I.V. Borovushkin, engineer, Kuybyshev Polytechnical Institute imeni V.V. Kuybyshev]

[Abstract] A study is made of the influence of hydrogen on the properties of the metal adjacent to the weld in type 16G2AF steel as a function of the time after welding and on its tendency to cold crack formation. The chemical composition of the steel (in mass percent) is 0.18 C, 1.64 Mn, 0.37 Si, 0.1 Ni, 0.12 V, 0.015 N, 0.02 S, and 0.025 P. Mechanical properties were determined after normalization at 930°C. Increasing hydrogen content in the welded zone with carbonitride hardening decreases the work of formation and propagation of cracks in the area adjacent to the weld, increasing the tendency of the steel toward cold cracking upon welding. The influence of hydrogen on crack formation near the weld results in a non-monotonic change in the characteristics with time, reaching a minimum value sometime after welding. When structures of hardened high-strength steels are welded, one must regulate not only the level of the mechanical properties of the welded joints and their individual zones, but also the hydrogen content in the welds. This is done by limiting the hydrogen content in welding materials such as electrodes. References 5: all Russian.

6508/13046
CSO: 1842/108

STRUCTURE AND PROPERTIES OF SURFACED METAL OF CARBON STEELS HARDENED BY PLASMA JET

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 20-22

[Article by L.K. Leshchinskiy, I.I. Pirch, candidates of technical sciences, S.S. Samotugin, engineer, and V.I. Shchetinina, candidate of technical sciences, Zhdanov Metallurgical Institute; V.V. Belostochnyy and A.A. Murashkina, engineers, Zhdanov Research Laboratory, Institute of Ferrous Metallurgy, USSR Ministry of Ferrous Metallurgy; and N.Kh. Solyanik, Zhdanov Branch, Odessa Institute of Maritime Fleet Engineers]

[Abstract] Results are presented from studies of the structure and properties of plasma jet-hardened surfacing metal on various steels. The plasmotron used had a channel diameter of 15.0 mm, three interelectrode sections, nozzle aperture of 6 mm, tungsten electrode diameter of 10 mm, distance from end of cathode to nozzle output cross-section 140 mm. Operations were adjusted to achieve the maximum hardness of each material without melting the surface. Significant dimensions of hardened zone, high-hardness, and finely dispersed structures were achieved, indicating that plasma hardening is a promising method of increasing the working capacity of mill rolls and parts of metallurgical equipment made of low-alloy materials which are capable of hardening. Plasma hardening of steels containing 0.3-1.4% carbon produces structures characteristic of laser and electron beam hardening. The dimensions of the heat-affected zone are determined by the plasma jet conditions and the chemical composition of the material.

References 6: all Russian.

6508/13046
CSO: 1842/108

INFLUENCE OF BEAM FLUCTUATIONS IN ELECTRON-BEAM WELDING ON STRUCTURE OF ZONE OF FUSION BETWEEN PEARLITIC AND AUSTENITIC STEELS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 22-24

[Article by A.P. Lopatko, candidate of technical sciences, and N.I. Nikitin, engineer, Moscow Power Engineering Institute]

[Abstract] The purpose of this work was to study the influence of beam fluctuation during electron beam welding on the nature and structure of the melted zone of pearlitic type 20 steel and austenitic type 08KH18N10T steel as delivered after welding. Templates for microscopic examination were cut across the fusion zone and etched electrolytically, revealing a crystallization layer 0.004-0.02 mm wide in the area of melting of the austenitic seam metal of the weld with the type 20 steel. The results indicate that the use

of beam fluctuation during electron beam welding with a longitudinal component with respect to the welded joint causes an increase in the impact toughness of the joint metal. The width of the crystallization interlayer decreases under these conditions. Circular rotation of the beam is recommended to allow welding with increased gap width and to achieve minimum width of crystallization interlayers. References 7: all Russian.

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CSO: 1842/108

UDC 621.791.92.621.373.826

TECHNOLOGY OF PLASMA BRONZE SURFACING OF MOLDING MACHINE PISTONS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 p 32

[Article by A.A. Vishnevskiy, G.H. Zarubin, engineers, and S.B. Rozhkova, candidate of technical sciences, Central Scientific Research Institute of the Technology of Heavy Machine Building, Sverdlovsk; V.D. Kudinov, candidate of technical sciences, and V.L. Masterskikh, engineer, Uralmash Production Association, Sverdlovsk]

[Abstract] Results are presented from development of a technology for plasma bronze surfacing using type BrAMts9-2 bronze during manufacture and repair of pistons with a wall thickness of 15-25 mm. The method used is based on the process of plasma welding by reverse polarity current. The method and equipment suggested were tested on a pilot scale at the Uralmash Production Association. Surfacing of experimental parts showed that the technology produces surface bronze without structurally free iron or deformation defects. The savings of ferrous metal per piston repaired is about 1/2 ton, per piston manufactured about 1/4 ton, and the savings in bronze wire in both cases is about 70 kg. The total annual economic effect of introduction of the technology is estimated at 34,000 rubles.

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UDC 620.179.18

HOLOGRAPHIC NONDESTRUCTIVE TESTING OF SOLDER JOINT QUALITY

Sverdlovsk DEFEKTOSEKSIYA in Russian No 11, Nov 85 (manuscript received 27 Jun 84; in final form 18 Apr 85) pp 65-69

[Article by N.A. Blagodatskikh and A.P. Fursov, Kharkov Aviation Institute imeni N.Ye. Zhukovskiy]

[Abstract] A study was made of specimens with solder joint defects on one, two, or several ribs over a length of 10-30 mm in order to evaluate the

capabilities of holographic optical band interferometry for nondestructive testing of soldered rib-reinforced structures. Pressure loading was found to be the most effective type in revealing solder defects in these rib structures. Thermal and vibration loading are less effective, though vibration loading may have been ineffective because of the unavailability of a sufficiently powerful exciter transducer. Examples of holographic interferograms are presented. The results obtained indicate that holographic interferometry in the optical band can be successfully used for nondestructive testing of solder joints if the presence of such defects results in anomalous deformation of the surface of the defect when it is loaded. The size of defects which can be detected depends on the strength properties of the structures. The use of pulsed radiation sources can eliminate the requirement for rigid mechanical stability of the recording apparatus.

References 7: 6 Russian, 1 Western (in Russian translation).

6508/13046
CSO: 1842/125

UDC 621.79:620.179.16

AUTOMATIC INSTALLATION FOR ACOUSTICAL TESTING OF LASER SPOT WELDING QUALITY

Sverdlovsk DEFEKTOSKOPIYA in Russian No 11, Nov 85 (manuscript received 4 Oct 84) pp 80-81

[Article by V.K. Korlyakov, V.V. Solodyankin, Ye.I. Bulatov and N.I. Kordyukov]

[Abstract] A description is presented of an installation for acoustical laser spot welding quality testing, based on measurement of the integral values of the acoustical emissions accompanying the welding process. The installation includes a sensor in acoustical contact with the welded product, plus an additional sensor, a photodiode in the optical system of the welding installation. Integral acoustical emission parameters are measured by integrating voltmeters. All information obtained by the integrators and counters in digital form is put into a computer, a program in which calculates the melting depth of the metal and the fatigue reliability coefficient of the welded joint. Results are immediately displayed on a terminal, which shows the results of testing up to 40 welds. A functional block diagram of the installation is presented. References 1: Russian.

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UDC 621.791.003.13

TECHNICAL-ECONOMIC COMPARISON OF VARIOUS METHODS OF WELDING THICK SHEET METAL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 3-5

[Article by A.N. Serenko, candidate of technical sciences, A.I. Patrikeyev and V.A. Shaferovskiy, engineers, Zhdanov Metallurgical Institute; I.G. Peshcherin, Ye.I. Antipenko and V.Ye. Gavrilov, engineers, Zhdanovtyazhmash Production Association]

[Abstract] The Zhdanov Metallurgical Institute has developed a multistep process for welding of thick sheet metal in a narrow gap with programming of the welding parameters. Welding is performed on standard equipment using a type A-1401 welding head or ADF-1201 tractor equipped with a special programming unit which changes the welding parameters to cause complex movement of the arc in the plane of the edges to be welded. Welding is performed under flux with a 4-5 mm diameter welding wire and cycling welding current. The method allows single-pass welding of sheets up to 80 mm thick with regulation of the parameters of the process of melting of the base metal and crystallization of the weld metal to avoid crystallization cracks and slag and gas inclusions and assures a favorable thermal cycle in the weld and adjacent metal. References 9: all Russian.

6508/13046
CSO: 1842/126

UDC 621.791.793

SPECIFICS OF METALLURGICAL PROCESSES OF ELECTRIC SLAG WELDING OF ALLOY STEELS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 5-7

[Article by M.B. Roshchin, candidate of technical sciences, M.D. Modzhuk, engineer, Central Scientific Research Institute of Machine Building Technology Scientific-Production Association; G.M. Babayev and V.Ya. Pavlov, engineers, Izhorskij Zavod Plant Production Association]

[Abstract] A study is presented of the changes in the chemical composition of slag and its metallurgical properties upon electric slag welding of long welds. Forgings 2.05 x 2.8 m in cross-section of type 25XhN3MFA steel (0.23-0.25% C, 0.23-0.27% Si, 0.33-0.38% Mn, 1.50-1.62% Cr, 3.2-3.5% Ni, 0.32-0.35% Mo, 0.10-0.12% V, 0.012-0.015% S, 0.007-0.012% P) were welded with four flat electrodes, each with a cross-section of 65 x 450 mm, of the same steel. The quantity of metal melted per kilogram of flux was maintained constant at 5-7 kg/hr. Slag samples were taken each 300 mm along the weld for chemical analysis and construction of graphs of the change in slag composition during the process of welding. It was found that silicon and manganese were oxidized during the course of welding and their oxides accumulated in the slag. The nature and intensity of oxidation processes were

determined by the content of the deoxidizing elements in the metal and the activity of free oxygen ions in the slag. Accumulation of sulfur in the slag and its liberation into the atmosphere are primarily determined by the activity of free oxygen ions in the slag, decreasing with the oxidation of silicon and the increasing content of its oxides in the slag. Neither the oxidizing potential of the atmosphere nor the deoxidation in the slag bath by aluminum influence the liberation of sulfur from the slag when welding is performed with type OF-6 flux. Welding materials with low sulfur content should therefore be used. References 5: all Russian.

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UDC 621.791.052.539.4

THICK SHEET WELDED JOINTS WITH REDUCED VOLUME OF MELTED METAL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 7-8

[Article by M.S. Babitskiy, candidate of technical sciences, A.I. Zhikharev, G.F. Razuvayev and S.G. Shuster, engineers]

[Abstract] A method is suggested for welding thick sheet rolled products by first welding the root weld, then placing a metal insert into the V-shaped weld, then completing welding around the insert. Comparative testing shows that the use of the metal inserts virtually does not decrease weld strength under static and cyclic tensile loading. The use of inserts does decrease the volume of metal which must be melted by 45-48%. References 4: all Russian.

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CSO: 1842/126

UDC 621.791.052.539.4.014

INFLUENCE OF COMPOSITION OF SURFACE METAL AND HEAT TREATMENT ON DISTRIBUTION OF RESIDUAL STRESSES IN BIMETALLIC ROLLS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 19-20

[Article by F.N. Ryzhkov, doctor of technical sciences, Voronezh Polytechnical Institute, and V.Ye. Magidenko, engineer, Komsomolsk-na-Amure Polytechnical Institute]

[Abstract] Results are presented from an experimental determination of residual stresses in cylinders surfaced with corrosion resistant wire of various types. The surfacing material was selected to allow a study of the distribution of residual stresses in cylinders with various coefficients of linear expansion of the surface metal applied to annealed blanks of type 20

steel. Residual stresses were determined in disks cut from the central portion of the rolls in the initial state after surfacing and after tempering. The distribution of residual stresses immediately after surfacing is almost independent of the chemical composition of the wire used, and is always unfavorable in terms of fatigue strength. Tempering changes the distribution of residual stresses. Compressive stresses appear at the joint, increasing the fatigue strength of the roll. Compressive stresses also arise on the surface of specimens surfaced with Sv-12Kh13 wire. When Sv-10Kh22N7ST wire is used the stresses are near zero at the surface, while austenitic and austenitic-ferritic wires yield tensile stresses at the surface.

References 8: all Russian.

6508/13046
CSO: 1842/126

UDC 621.791.77.621.791.052:539.4.014

INFLUENCE OF HIGH FREQUENCY INDUCTION TREATMENT ON WELDING STRESSES IN JOINTS OF DISSIMILAR TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 20-22

[Article by F.G. Gonorovskiy, candidate of technical sciences, Central Scientific-Research and Planning-Design Boiler and Turbine Institute imeni I.I. Polzunov Scientific-Production Association]

[Abstract] A study of the stress state after surfacing was performed on specimens imitating turbine vanes, the entry edges of which are protected from erosion. Manual argon-arc surfacing was performed with TS8 alloy onto sheets of alloy TS5 after annealing at 880°C. A sublayer of the plastic alloy SPT2 was applied to some specimens to increase crack resistance. Residual welding stresses were decreased by local heating of the weld and adjacent zone in a single-loop inductor. The influence of induction heating temperature in the 750-1050°C interval, holding time 5-7 s, and the influence of holding time in the 5-130 s interval, temperature 750-950°C, on residual stresses were studied. Induction heating at up to 7 seconds holding time caused no significant relaxation of residual welding stresses. Some 90-100 s were required to achieve residual stress reduction by heating to 750-950°C in joints in α -titanium alloy made with an $\alpha+\beta$ welding wire (induction frequency 66 kHz). The $\alpha+\beta$ wire achieves lower residual stress than α -titanium wire. Local induction heating also produces thermal compressive stresses at the edges of the joints. References 6: all Russian.

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HIGH STRENGTH WELDABLE TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 24-26

[Article by A.I. Khorev, doctor of technical sciences]

[Abstract] A study was made of structural changes and mechanical properties of joints in sheets made by automatic argon-arc welding without a filler. The changes in mechanical properties of welded joints after welding were determined. A saturated solid solution of the α' -phase of the weld metal, complexly alloyed with four β -stabilizers, has greater strength (tensile strength of 1250 MPa at a bend angle of 35°) than a solution supersaturated with one β -stabilizer (tensile strength of 930 MPa at $\alpha = 40^\circ$) in the system Ti-3Al-V. The distribution of alloying elements in the metal and crystalline structure defect density, as well as the physical and mechanical properties of the phase components and elements of the structure, are used to develop the principles of complex alloying of weldable titanium alloys. Utilization of the principles of macro- and microalloying can achieve uniform participation of the phase components and elements of the structure in resistance to plastic deformation, while structural concentrators in the weld metal and adjacent zone have little influence on strength, significantly improving the usage properties of the alloys. High strength weldable titanium alloys VT23 and VT19 are developed, having a good combination of mechanical properties.

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UDC 621.791.4.539.378.3

INTERACTION OF CONTACTING SURFACES DURING SUBSEQUENT ANNEALING IN DIFFUSION WELDING OF TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 85 pp 32-34

[Article by V.I. Grigorevskiy, candidate of technical sciences, and V.K. Akinin, engineer]

[Abstract] A study is made of the influence of annealing on the interaction of surfaces under conditions of diffusion welding after complete contact is achieved between them without significant joint strength. Titanium alloys VT14 and OT14 with large-grain plate structure were obtained by preliminary annealing of specimens at 1273 K, above the upper limit of the $\alpha + \beta \rightleftharpoons \beta$ conversions, for 30 minutes. An external pressure of 9.8 MPa was applied at 293-1123 K to achieve full contact. The interaction of the surfaces upon formation of full contact was not accompanied by an improvement in the mechanical properties of the joints at temperatures below 998 K. The specimens fell apart without application of external force. Subsequent high

temperature annealing of specimens in contact without application of external welding force produced joints with properties close to those of the base material. This was found to result from dissolution of oxides contained in the metals. The rate and completeness of purification of the surfaces and their subsequent joining are activated by increasing the degree of dispersion of oxides as a result of plastic deformation of the material at the interface at low temperature, or by increasing the temperature of subsequent annealing. References 4: 3 Russian, 1 Western.

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EXTRACTIVE METALLURGY AND MINING

PLANS FOR MINING THE ANGARA RIVER LEAD-ZINC DEPOSIT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Jan 86 p 2

[Article by special correspondent V. Sbitnev: "Underwater Treasure"]

[Text] Having created a lead-zinc deposit here, nature has covered it securely with the waves of the Angara River. Geologists only stumbled upon this treasure by chance in the 1960's. But how can the ore be mined under water? It took 20 years for scientific studies and the suggestions of practical experts concerning this problem to finally appear. The Draft Basic Guidelines contains a line about the development (*osvoyeniye*) of the Gorevskoye lead-zinc deposit in Krasnoyarsk Kray.

Something has been done also in the past years. The construction subsection of the USSR Ministry of Power and Electrification has built a small dike and pushed the Angara River water away from the shore. A small open pit has been established on the former river bottom. The construction of pilot-scale enterprise has started, and a new settlement, Novoangarsk, has grown near the Angara River mouth. It already has 20 houses and a school, and a kindergarten is under construction. In 1987, this small enterprise, which is designed to mine and process 1,000 tons of ore, will join the operational ranks in order to help the miners with the development of technology for mining large volumes of ore under such difficult hydrogeological conditions.

V. Zemtsov, the manager of the future combine, has two main worries for the first year of the five-year plan: to push through a good road to the Yenisey highway and to provide housing for the construction site.

The construction subdivisions of the USSR Ministry of Power and Electrification are busy now with creating the support base for the construction of the Middle-Yenisey hydroelectric power plant. Its dam will raise the water level of the Yenisey and Angara Rivers by more than 100 meters.

"The planned dike of the first phase of the combine"--says V. Rodinov, chief project engineer of SibsvetmetNIiprojekt [Siberian State Scientific Research Institute for the Designing of Nonferrous Metallurgy Enterprises]--"will be almost 1.5 km long and 440 m away from the shore. Later, after a number of years, we will need a dike more than 8 km long, and it will push the Angara River 1,200 m away from the shore. The main pit for mining the valuable ore will be situated here."

A lot of large-scale, interesting work is planned. There is one trouble: the general contractor who will build the main dike and the main complexes of the mining and beneficiation combine has not been designated thus far, although an attractive settlement for 12,00 people has already been designed and the remaining documentation is being prepared.

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NINTH STAGE ON-STREAM AT OKTYABRSKIY MINE IN NORILSK

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 5 Jan 86 p 1

[Article by K. Kolotkov: "Self-Propelled Machinery Lowered to the Oreface"]

[Text] The ninth stage has been put on-stream at the Oktyabrskiy Mine, the largest nonferrous-metal mining enterprise in the country.

The principal supplier of raw material to the Norilsk metallurgists has caught its second wind. Now the miners can lower large self-propelled machinery, which previously had to be disassembled above ground, through the freight shaft. The up-to-date-equipped control room has connected the mine's command post to even the most remote underground sections, which are spread out over 10,000 square kilometers.

The Oktyabrskiy miners have pledged to attain the design capacity of the new stage ahead of schedule.

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CSO: 1842/129

Smelting of Lead-Zinc Ore without Coal at Ust-Kamenogorsk Combine

Moscow IZVESTIYA In Russian 8 Jan 86 p 1

[Article by special correspondent V. Shchepolnik: "Smelting Without Coal"]

[Text] A new metallurgical unit went on stream at the Ust-Kamenogorsk Lead-Zinc Combine imeni V.I. Lenin.

This event had been awaited for a long time. The oxygen-fluidized cyclone-electrothermal process (the full name of the new process) has been created (sozdan) by Soviet scientists for the processing of polymetallic ores and concentrates according to a completely different technology from that used till now. The technology combines several operations in one unit. This makes it possible to lower operating costs by one-third, to completely mechanize and automate the process, thus releasing a substantial number of workers, and to greatly improve working conditions.

The process also saves large quantities of fuel transported to the combine. Nature itself supplies the fuel on the spot.

The unit brought on stream at Ust-Kamenogorsk is effective in terms of environmental protection.

To top it all off, the unit is small; it is several times smaller than presently operating furnaces. On the other hand, upon attaining full capacity, the furnace, on the basis of productivity, will replace a large part of all the metallurgical equipment at the combine.

In a word, the aurora of the first melt produced by the new technology will "illuminate the way" for modernization not only of the Ust-Kamenogorsk Lead-Zinc Combine, but also of the entire industry.

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CSO: 1842/129

UDC 622.765

CHANGE IN ELECTROCHEMICAL PROPERTIES OF GALENITE UNDER THE INFLUENCE OF LASER RADIATION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 28 Jun 84) pp 18-21

[Article by V.Ya. Badenikov, S.B. Leonov and Yu.K. Skruchayev, Irkutsk Polytechnical Institute, Department of Automation of Production Processes]

[Abstract] Laser ionization of a sulfide mineral is a process of transforming certain atoms in the crystalline lattice into charged ions due to the transfer of electrons from the valent zone of the crystal to the conductivity zone. The general concept of selective photochemical action of laser light on sulfide minerals is explained. The criterion of selective excitation of lead is not very rigid, requiring shifting of one spectral line. The conductivity of semiconductor sulfides is quite sensitive to external effects, laser radiation increasing conductivity by hundreds of thousands of times. Laser radiation striking rectangular galenite electrodes was found to induce an electric current, which radiates electromagnetic waves. The power loss per unit surface area is calculated. The electrode potentials of sulfides were measured before and after exposure to laser radiation at various energies. Laser radiation caused structural changes, cracks and craters, on the surface, increasing with increasing radiation power. The electrode potential of the mineral was restored to its previous values in 1-1.5 hours of immersion in tap water at 15°C, pH = 7.3. The negative value of electrode potential increased with increasing laser pulse energy.

References 4: 2 Russian, 2 Western (in Russian translation).

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CSO: 1842/121

OPERATIVE IDENTIFICATION OF TYRNYAUZ DEPOSIT ORE GRADES

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 24 Jul 84) pp 22-25

[Article by L.V. Soroker, T.V. Oleyinichenko and I.A. Fedkovskiy, Northern Caucasus Branch, All-Union Scientific Research and Design Institute Tsvetmetavtomatika]

[Abstract] Experiments on ore grade identification were conducted by grinding four samples in a laboratory bar mill to a size of 60% -0.074 mm, adding hydrochloric acid at the rate of 50 cm³/kg of ore two or three times, agitating the slurry for 1 minute each time, then measuring the pH. Clear differences in the pH were found for different grades of ore. The method can be used for ore quality testing during mining, storage, burdening, blending, and transportation to the concentrating mill. References 4: all Russian.

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UDC 541.128:542.61:(546.73+546.74)

KINETICS OF EXTRACTION OF COBALT AND NICKEL BY DI-2-ETHYLHEXYL PHOSPHORIC ACID

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 19 Jun 84) pp 25-29

[Article by N.F. Kizim and Yu.P. Davydov, Novomoskovsk Branch, Moscow Chemical Technology Institute, Department of Physical and Colloidal Chemistry]

[Abstract] A detailed study is presented of the kinetics of extraction of cobalt (II) and nickel (II) by di-2-ethylhexylphosphoric acid in order to clarify the mechanism of the process. The kinetics of the extraction process were studied by a diffusion cell method with agitation. The studies established the basic regularities of the process, the rate of which is high. The rate of the process rises sharply in the emulsion mode and equilibrium is achieved in less than 1 minute. The rate of the process depends greatly on initial concentration of extraction agent. The rate of the process also varies with the acidity of the aqueous phase. Decreasing acidity increases the rate of the process. The process is complicated by the formation of a film between phases, causing additional diffusion resistance which significantly exceeds the phase resistance. References 29: 12 Russian, 17 Western.

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UDC 622.7:622.348.1

STUDY OF ALKALINE DECOMPOSITION OF LEAN OXIDIZED NICKEL ORE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 24 Jul 84) pp 29-33

[Article by O.D. Orlova, P.I. Andreyev, R.D. Divinskaya and R.G. Sizova, Institute of Mineral Resources, Ukrainian SSR Ministry of Geology, Laboratory of Beneficiation of Nonferrous Metal Ores]

[Abstract] Studies were performed on oxidized ocher-siliceous nickel ore containing 28.3% talc, 35% quartz, 24% iron hydroxides, 7.7% koalinite and halloysite, 2.9% magnetite, and other secondary minerals. The ore was decomposed by leaching ore charges ground to 0.1 mm in 20 and 40% sodium hydroxide solutions at 100 and 200°C. The degree of desilication of the ore was significantly influenced by the concentration of sodium hydroxide and the time and temperature of leaching. Autoclave leaching also increased desilication, particularly with the 40% sodium hydroxide solution, achieving 81% desilication in 6 hours. However, this decreased the quantity of nickel in the residue due to partial dissolution of the nickel. Oxidation of the ore by roasting intensifies the process of alkaline breakdown and hinders transfer of nickel into the solution. Conditions suggested are: oxidation at 700°C for 1 hour; a sodium hydroxide concentration of 20%; contact time of 3 hours; and a solid:liquid ratio of 1:5. References 4: all Russian.

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UDC 622.765:546.791:541.8

FLOTATION SEPARATION OF URANIUM (VI) FROM SULFATE SOLUTIONS BY SUCCESSIVE TREATMENT WITH TOA AND ANP-2

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 6 Jun 84) pp 100-102

[Article by L.D. Skrylev and V.V. Menchuk, Odessa State University, Department of Physical Chemistry]

[Abstract] Results are presented from experiments intended to clarify the basic regularities of the process of flotation separation of uranium from its dilute sulfate solutions by successive treatment with trioctylamine (TOA) and ANP-2, which is a mixture of the hydrochlorides of primary aliphatic amines containing 8 to 18 carbon atoms in the hydrocarbon chain. The experiments showed that up to 75% of the uranium can be extracted from the solutions by this method in not over 15 minutes flotation time. Neither TOA nor ANP-2 can achieve the same results alone. The optimal consumption of

flotation reagents for this purpose is 5 moles of TOA and 2 moles of ANP-2 per mole of uranium, which achieves as much as 98% uranium extraction.
References 7: 5 Russian, 2 Western.

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UDC 669.872

EXTRACTION OF INDIUM FROM DUSTS AND SUBLIMATES OF COPPER-SMELTING PRODUCTION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 85 (manuscript received 5 Jul 84)
pp 104-105

[Article by G.I. Maltsev, Yu.B. Kholmanskikh, V.V. Sviridov and N.K. Sitnikova,
Ural Wood Technology Institute]

[Abstract] A study is made of processes of simple and sorption leaching of dusts and sublimates from the Central Urals Copper Smelting Plant. The sublimate to sulfuric acid ratio was 1:6, and the ratio of the volume of sorbent to the total slurry used in sorption leaching 1:10-20. The studies showed that with simple one-stage leaching, the degree of extraction of indium from sublimates is not over 50%. Replacement of ordinary leaching with sorption increases the degree of extraction of indium to 93-95% due to the shifting of the equilibrium in the direction of dissolution by selective sorption of indium ions from the slurry onto the cationite. Optimal parameters were found to be: concentration of sulfuric acid 140 g/dm³, total leaching time 6 hours, sublimate to sulfuric acid ratio 1:5, temperature 80°C, pressure 0.1 MPa. Under these conditions, 96-98% of the indium goes over into solution, but its sorption onto the ionite remains at 60-65%, a result of suppression of the ionization of the functional groups of the cationite in strongly acid solutions and of the competing influence of impurity metal cations. A version of two-stage sorption leaching of dusts and sublimates was therefore developed, achieving 94-96% sorption of the indium in the solution during the second stage.

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UDC 669.721.3:338.45

EFFECTIVENESS OF THE CYCLONE METHOD OF MELTING CARNALLITE

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 46-47

[Article by P.A. Donskikh, E.M. Lysenker and Yu.A. Korotkov]

[Abstract] One promising trend in the creation of high productivity apparatus and economical technologies for the second stage of the dehydration of carnallite is melting and dehydration of carnallite which has been dehydrated in fluidized bed furnaces in a cyclone chamber at high heating gas velocities. A pilot-scale cyclone installation was used in the development of a slime-free process, producing 800 tons of high quality anhydrous carnallite melt containing chlorides of magnesium, potassium, and sodium, 1.6-2.6% magnesium oxide, and 1.8-9.9% water. Based on the experimental data, a pilot-scale installation producing up to 400 tons of melt per day is planned. Creation of automated apparatus for the second stage of the dehydration of carnallite will allow realistic planning of completely mechanized plants for the production of magnesium from carnallite.

References 9: all Russian.

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UDC 546.841.028:66.066.7:66.082.27

CONCENTRATION OF CHLORIDE WASTES FROM PROCESSING OF LOPARITE CONCENTRATES

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 53-56

[Article by Yu.P. Kudryavskiy, A.V. Belkin, L.V. Vasilenko, A.L. Smirnov and A.G. Yukov]

[Abstract] Loparite concentrate contains (in terms of oxides), Z: 30-33 rare-earth elements, 8.0-8.6 Nb, 0.6-0.7 Ta, 36-39 Ti, 0.7-1.5 Fe, 0.5-1.0 Th, plus V and decay products of Th and U, as well as K, Na, Mg, Ca, Si, P, and other elements. The shortcomings of existing technologies of decontamination of spent melt from salt irrigation filters include the low degree of concentration of radioactive metals and the formation of large quantities of waste requiring special burial. These shortcomings result from the lack of selectivity of the process. As the slurry is treated with lime milk, Fe (III), Al, and rare-earth element hydroxides are precipitated together with the thorium. Studies have shown that the selectivity of the isolation of thorium from the solution can be significantly increased by preliminary reduction of Fe (III) to Fe (II), precipitation of the slurry up to pH 4-5 under conditions eliminating or reducing local supersaturation of the solution when the precipitating agent is introduced. Studies show that with a high degree of extraction of thorium, processing of the solution with steel scrap significantly increases the content of Th in the precipitate and that the greatest

concentration of Th is achieved by treatment of the solution with steel scrap and then by a caustic soda solution up to pH 4.0-5.0. The technology developed increases the concentration of thorium by 5 to 10 times and reduces the quantity of thorium-containing wastes to be buried. References 5: all Russian.

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UDC 622.342:66.074.7

TESTING OF COUNTERCURRENT SORPTION-FLOTATION TECHNOLOGY FOR EXTRACTING GOLD FROM CYANIDE SLURRIES

Moscow TSVETNYYE METALLY in Russian No 12, Dec 85 pp 77-78

[Article by N.A. Dementyeva, D.I. Kogan, V.K. Chernov and S.B. Leonov]

[Abstract] A sorption-flootation technology with countercurrent movement of sorbent and slurry has been suggested to decrease the losses of gold with cyanidation cake and with the liquid phase. The sorbent used is activated carbon modified with organic reagents. Laboratory studies were performed in a flotation machine. The results of extraction of gold from products used in cyanidation indicates the possibility of achieving a rich concentrate and reducing losses of gold with the tailings. No gold loss with the liquid phase was observed. The studies showed that extraction of gold from cyanide slurries can be successfully performed using sorption-flootation technology with countercurrent movement of slurry and sorbent and a sorbent of activated carbon modified with organic reagents.

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UDC 622.012

CONSTRUCTION OF KOSTOMUKSHA MINING AND BENEFICIATION COMBINE COMPLETED

Moscow GORNYY ZHURNAL in Russian No 12, Dec 85 pp 3-4

[Article by P.I. Smirnov, Prommashimport All-Union Association]

[Abstract] The Kostomuksha Mining-Beneficiation Combine has been completed and put on line in the northern Karelian ASSR. The celebration marking the opening of the combine was attended by Comrade N.A. Tikhonov as well as the President of Finland, M. Koivisto. Completion of this joint Soviet-Finnish project indicates the mutual benefits of cooperation between the two nations. Finnish construction firms were involved in the project. Construction included building the city of Kostomuksha on the banks of Lake Kontokki; 39 multistory residential buildings, a trade center, house of

culture, school, kindergarten, and other projects for a total of 681,000 m². Now that construction of the combine has been finished, its rated annual capacity is to be 24 million tons of raw iron ore, 9.75 million tons of concentrate, and 8.52 million tons of pellets.

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UDC 622.7:681

AUTOMATED SYSTEMS FOR TESTING SLURRY PRODUCTS AND CHARGE MATERIALS

Moscow GORNYY ZHURNAL in Russian No 12, Dec 85 pp 11-12

[Article by Yu.G. Goncharov, candidate of technical sciences, V.V. Gorbunov, engineer, V.G. Kucher, candidate of technical sciences, B.I. Tsinis and A.V. Shkvirskiy, engineers, Scientific Research and Experimental Design Institute for the Automation of Ferrous Metallurgy]

[Abstract] The authors' institute has developed and is introducing at several mining and beneficiation plants an automated system for collection and delivery to the plant laboratory of samples of charge materials. The operating principle of the system is based on automatic sampling at given intervals of primary concentrate specimens which are subsequently reduced. The final specimen is placed in a cartridge at a loading station and transported by compressed air through pipes to an unloading station where specimens are prepared for analysis. A boom is used to allow transportation samples taken at two different places through a single pipe to a single unloading point with subsequent return of sample transportation cartridges to both sampling points. The control system consists of a control panel and an operator's panel. The control panel is based on series K-155 integrated microcircuits and is a modular device. The operator's panel includes switches, lights signalling switch positions, plus emergency switches and signal lights.

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UTILIZATION AND PROSPECT FOR DEVELOPMENT OF KORSHUNOV MINING AND BENEFICIATION COMBINE ORE BASE

Moscow GORNYY ZHURNAL in Russian No 12, Dec 85 pp 24-27

[Article by A.V. Sherstneva and B.F. Malyshev, geologists, Korshunov Mining and Beneficiation Combine]

[Abstract] The RSFSR Ministry of Geology is now undertaking detailed surveys of reserves suitable for underground mining in the Korshunov and Rudnogorsk

deposits. As a result, some 600 to 700 million tons of iron ore are planned for utilization. The Krasnoyarskoye, Oktyabrskoye, and Polivskoye deposits are also listed as possible future sources of raw materials for the combine. The geological structure of these present and future raw material sources for the combine is discussed. Shortcomings in past surveys, such as the fact that the inflow of water into the mine was underestimated by a factor of 3, are noted. Significant steps taken to assure a raw materials base for the combine include comparison of reserves based on data from detailed prospecting and operation of the deposit, basically confirming the calculated reserves, and geological mapping of the Korshunov deposit. The Rudnogorsk deposit has been resurveyed, additional engineering-geological studies have been performed at the mine, and studies of the hydrogeology of deeper levels in the Korshunov mine and the interrelationship of saltwaters with overlying levels have been undertaken. Computers have been used to process geological information to help assure accuracy of raw materials prediction for use past the year 2000.

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RESULTS OF MINE TESTING OF TWO-LAYER EXTRACTION OF THE THIRD STRATUM AT THE STAROBIN POTASH DEPOSIT

Moscow GORNYY ZHURNAL in Russian No 12, Dec 85 pp 34-36

[Article by V.A. Sorokin, candidate of technical sciences, B.I. Petrovskiy, A.F. Bublis and P.I. Kalinichenko, mine engineers, Belorussian Branch, All-Union Scientific Research Institute of Halurgy]

[Abstract] A combined system of working is now in use to extract the third potash stratum of the Starobin deposit, the upper layer being taken by a long wall method, while the lower layer, consisting of three substrata, is extracted by a chamber method using Ural-10KS machines. This has resulted in depletion of the ore and loss of ore left in pillars between chambers. A new technology for two-layer extraction by mechanized systems with separate preparation of the layers was developed to eliminate these problems in 1980. The layers are extracted in paired long walls in sequence or simultaneously, depending on geological conditions. The upper layer is extracted in advance of the lower, using a rocksalt stratum as the roof for the lower long wall. References 2: both Russian.

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USE OF PLATE-TYPE THICKENERS IN BENEFICIATION OF LISAKOVSKIY ORES

Moscow GORNYY ZHURNAL in Russian No 12, Dec 85 pp 46-48

[Article by O.K. Shcherbakov, candidate of technical sciences, Ye.V. Pryanichnikov, mining engineer, A.M. Komlev, candidate of technical sciences, A.S. Gorelykh, mining engineer, Ural Scientific Research and Planning Institute of the Mechanical Processing of Useful Minerals, E.P. Iovik, V.A. Naydenov, A.F. Fedin and A.T. Polkovnikov, mining engineers, Lisakovsk Mining and Beneficiation Combine]

[Abstract] A plate-type thickener has been tested at the Lisakovsk mining and beneficiation combine as a classifier rather than a slurry clarifier. The effectiveness of classification reaches its maximum value of 77% at a loading of $120 \text{ m}^3/(\text{m}^2 \cdot \text{h})$. Further increases in throughput do not influence effectiveness of classification but do improve the quality of thickener sand, the content of particles smaller than $44 \mu\text{m}$ in the sands dropping to 7%, while the percentage of this size range which winds up in the sand drops from 20 to 5%. Industrial testing of the plate-type thickener with highly diluted slurries confirmed the high effectiveness of its operation as a classifier. The throughput of the thickener for oolite brown iron-ore was 70 to $100 \text{ m}^3/(\text{m}^2 \cdot \text{h})$ and the classification effectiveness 80%. The content of solids in sand and liquid drain was 35 and 0.08%. References 2: 1 Russian, 1 Western.

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CSO: 1842/119

MISCELLANEOUS

UDC 539.2:621.315.61.548.0:029.62

ELECTRICAL PROPERTIES OF RbAg_4I_5 SUPER ION CRYSTALS AT MICROWAVE FREQUENCIES

Moscow FIZIKA TVERDOGO TELA in Russian Vol 27, No 10, Oct 85 (manuscript received 16 Oct 84; in final form 12 Apr 85) pp 3010-3012

[Article by A.P. Kezhenis, A.S. Orlyukas, G.I. Vaskela and A.K. Ivanov-Shits, Vilnius State University imeni V. Kapsukas]

[Abstract] A study is made of the variation of $\epsilon(T,\nu)$ and $\sigma(T,\nu)$ at 100-300 K in the frequency range of $7 \cdot 10^8 - 5.3 \cdot 10^{10}$ Hz in RbAg_4I_5 crystals. In the γ phase at 110 K, $\epsilon = 7$ and is practically independent of ν in the frequency range studied. At 118-122 K, there are sudden changes in σ and ϵ which are characteristic for phase transitions of the first kind, while in the β - α area, phase transitions are observed only by a break on the $\epsilon(\nu)$ curve, whereas in the α phase ϵ is practically independent of temperature. A possible microwave dispersion mechanism in disordered RbAg_4I_5 crystal phases is suggested. At 128 K and 10^9 Hz the relaxation and phonon contributions to ϵ in the crystals are over twice as great as the electron polarization contribution. At 128 K and $5.3 \cdot 10^{10}$ Hz $\epsilon = 7$, possibly a result of low frequency oscillation of silver ions in their local positions, plus the contribution of electron polarization. References 20: 11 Russian, 9 Western.

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